ETROLEUM
REFINING
•
ROCHEMICAL
NUFACTURING
•
GAS LIQUID
RECOVERY

SEPTEMBER, 1957

Petroleum Processing

The Future Stays
BRIGHT
page 101

15 Fast-Reading
OUTLOOKS
page 109

6th Annual
PLANT DIRECTORY
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Bigger this Year
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Cooling with Air AND MINIMUM WATER IN A MODERN REFINERY

Process cooling in Cosden Petroleum Corporation's new West Texas refining units is largely by direct use of air. Over 250 million BTU's per hour are dissipated directly to five billion standard cubic feet per day of air moved by 38 fans in HUDSON Solo-aire or Combin-aire units.

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(To obtain more data on advertised products see page 222)

Reader's Guide

What's New in Petroleum

PETROCHEMICALS— 1957 Report

A special 52-page section in six parts

1 —**Petrochemicals Race Ahead**—a depth outlook for the industry and its future, by Henry G. McGrath, M. W. Kellogg Co., who finds that in the next 10 years pretrochemicals will become 50% of all chemical production, that growth opportunities—already enormous—will keep on growing. **p. 101**

2 —**The Industry Today**—your annual status report on current operations in comparison with the recent past few years. **p. 108**

3 —**The Major Petrochemicals and Where They're Going**—Fast-reading, supply-demand outlooks on 15 important products, prepared by authorities in their fields. Petrochemicals discussed this year include: ammonia, aromatics, carbon black, polyethylene, polypropylene, styrene, synthetic detergents, synthetic fibers, urethanes, cresylics, formaldehyde, butadiene, ethylene, and sulfur. **p. 109**

4 —**Sixth Annual Plant Survey** of the petrochemical industry in the United States and Canada. There are now 206 companies in the field, with 409 plants, in operation, planned or under construction. **p. 121**

5 —**Bigger this Year, the Petrochemical Glossary.** Here's a list of more than 350 products, keyed to the plants in this year's directory, plus a brief description of each material. The descriptions include chemical composition, physical properties, chemical derivation, and principal end uses. **p. 139**

6 —**New this Year, a Who's Who of Engineering and Service Firms** that serve the petrochemical processing industry. **p. 149**

PETROLEUM PROCESSING
A McGRAW-HILL PUBLICATION
September, 1957
VOL. 12—No. 9

Petroleum Processing is published monthly by McGraw-Hill Publishing Co., Inc., James H. McGraw (1860-1948) founder. Published prior to September, 1946, as the Technical Section of *National Petroleum News*, and including *International Petroleum Technology*. Publication office, 871 N. Franklin St., Chicago 10, Ill. See panel on next page for directions regarding subscriptions or change of address.

Executive, Editorial, Circulation, and Advertising Offices: 330 West 42nd St., New York 36, N.Y. Donald C. McGraw, President; L. Keith Goodrich, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising Sales; A. R. Venezian, Vice-President and Circulation Coordinator.

Petroleum Processing's articles are indexed in the Industrial Arts Index, the Engineering Index, and Chemical Abstracts. Petroleum Processing publishes its own annual index in the December issue.

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Postmaster . . Please send form 3579 to Petroleum Processing, 330 West 42nd St., New York 36, N. Y.

Processing for September, 1957

PETROLEUM REFINING I | PETROCHEMICAL MANUFACTURING II | GAS LIQUIDS RECOVERY III | RESEARCH & DEVELOPMENT 1 | DESIGN & ENGINEERING 2 | PLANT OPERATION 3 | MAINTENANCE & CONSTRUCTION 4 | MANAGEMENT & PERSONNEL 5

Thermodynamic Properties of Pure and Mixed Hydrocarbons

Part II in a series by Merk Hobson and James H. Weber, covers latent heats of vaporization of hydrocarbon mixtures. It will bring you fresh, up-to-date help on methods for determining data. **p. 153**

I II III 2

Technical tips for you

Today's up-to-the-minute data from operating men and engineers. The seventh and last in your 1957 series of articles from the popular question-and- answer sessions of the WPRA Fall Meeting. See "Treating and other Problems." **p. 163**

I 3

Use plastics to handle acids

That's what Atlantic Refining Co. decided to do in a contact plant at Philadelphia which produces some 150,000 lb/day of sulfuric acid. Here are the technical details on the problem they faced and the solution to that problem. **p. 158**

I 2 3 4

Is your data file complete?

Are you using the "Clip-n-File" departments to full advantage? This month's Process Data Sheet, No. 22, **p. 171,** covers the Stengel-C & I ammonium nitrate process, and the Engineering Data Sheet, No. 21, **p. 193,** has data on unfired pressure vessels.

I II III 1 2 3 4 5

What to do with spent filter clay

You can turn this into a valuable material, according to Sun Oil's George F. Felton, who tells how the Marcus Hook refinery uses clay to reclaim swampy land, build soil-bearing foundations, and as a water stop in dikes and levees. **p. 160**

I 2 3 4

Try aerial mapping

It can save you both time and money on your next expansion or new construction project. Here's how the technique was used to advantage by Tidewater Oil Co. when it faced a 5000-acre surveying problem for its new Delaware refinery site. **p. 162**

I II III 2 5

DEPARTMENTS

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SUBSCRIPTIONS are solicited only from executives, supervisors, engineers, and other technical personnel engaged in petroleum and petrochemical research and development, and in the design and engineering, operation, maintenance and construction of petroleum refining, petrochemical processing and gas-liquids-recovery plants. **Position and company connection must be indicated on subscription orders.**

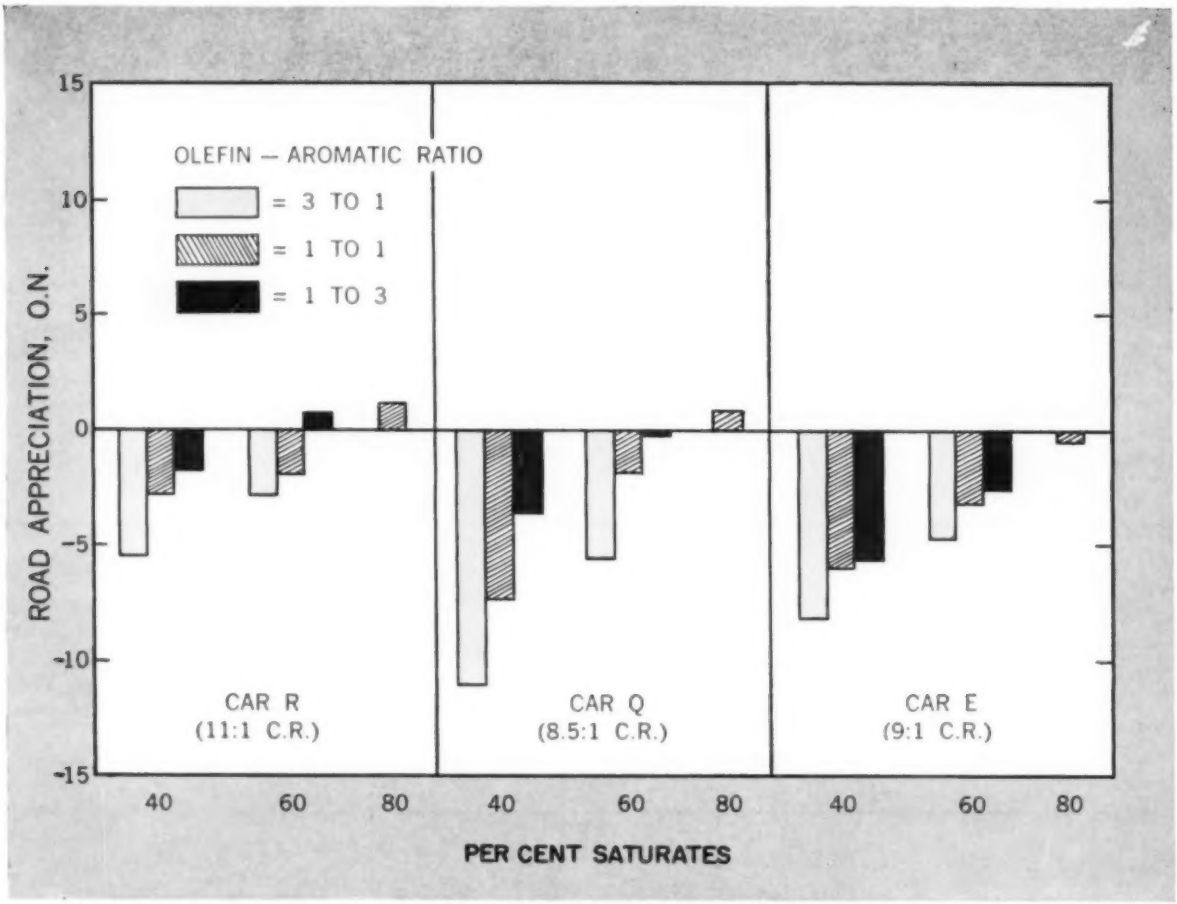
Subscription rate: United States, Canada, and all other countries, $2 per year, single copies $1.

Send subscription correspondence and change of address to Subscription Manager, Petroleum Processing 330 West 42nd St., New York 36, N.Y. On address changes, give old and new addresses, and enclose an address label from a recent issue if possible. Please allow one month for change to become effective.

Continue "Readers' Guide" on p. 169

HOW TO USE IT:

Your new "Readers Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest: roman numerals indicate industries; arabic numerals show fields of activity. Secondly, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you—THE EDITORS



Effect of hydrocarbon-type concentration on the road appreciation of leaded blends containing three hydrocarbon-types. Tests at 3000 RPM were made in two 1955 cars of conventional engine compression ratio and in one experimental model of 11-to-1 compression ratio

Ethyl Research Offers Refiners New Benchmark in Rating Gasoline Test Blends

Road Performance Predicted From Laboratory Data

BY F. D. BUERSTETTA, Refinery Technology Division, Ethyl Corporation Research Laboratories

A CONTINUING research program in Ethyl Corporation's Detroit Laboratories has produced new data that will assist refiners in blending their fuels for optimum road performance.

These data are available in a published report entitled, "Road Performance of Ternary C_7-C_9 Hydrocarbon Blends." It is the fifth in a series of progress reports on the program which is aimed at gaining a more thorough understanding of the principles relating gasoline hydrocarbon composition to road antiknock performance.

In this latest report, consideration of the effects of hydrocarbon-type concentration in various blends containing three hydrocarbon types in the C_7-C_9 range at two tetraethyllead concentrations forms the basis for discussion.

 (To obtain more data on advertised products see page 222)

Binary Blend Testing Preceded Ternary Blend Studies

All four previous reports were based on the road antiknock behavior of 99 blends, each of which contained two types of pure hydrocarbons in the C_7-C_8 range.

These blends, composed of toluene and diisobutylene separately added to mixtures of isooctane and n-heptane, were extensively tested to find the relationships that exist between road performance and the fuel variables commonly defined by laboratory tests:

Hydrocarbon type and concentration, Research and Motor octane number, and TEL concentration.

An Ethyl Corporation Research team evaluates data obtained in the most recent study of the relationship of fuel variables to road performance.

The program's scope included numerous combinations of hydrocarbon concentration and TEL content at the Research octane levels of 92, 96 and 100, thus permitting several different approaches to the data analysis.

Blends considered in this most recent phase of the program also were of toluene and diisobutylene, representing aromatics and olefins respectively in saturate mixtures of isooctane and n-heptane.

These components were combined to give ternary blends containing 40, 60 and 80% saturate concentration with olefin-to-aromatic ratios of 1-to-3, 1-to-1, and 3-to-1 at each saturate level.

A nominal Research octane number level of 100 was maintained for all blends at TEL concentrations of 0.0 and 3.0 ml per gallon.

In order to provide comparisons with the binary blend studies, road ratings were conducted in the same 1955 passenger cars that were used in previous tests, (nominal compression ratios of 9.0-to-1 and 8.5-to-1).

The blends also were rated in a car having an 11-to-1 compression ratio engine to permit evaluation of performance in engines of the future. All data were interpreted in terms of "road appreciation" to give refiners a better idea of the effectiveness of each blend.

New Tests Confirm Earlier Conclusions

Test results of blends containing three hydrocarbon-types verified the previous conclusions based on binary blend studies —that hydrocarbon-type and concentration, Research and Motor octane number, and TEL level are the most important factors affecting the road performance of gasoline.

Analyses of test data produced these conclusions:

1. The addition of TEL from 0.0 to 3.0 ml per gallon significantly increased road appreciation in all cars over the speed range. This effect is greatest at high engine speed.

2. TEL generally has the greatest effects in fuels containing highest aromatic and saturate percentages.

3. Increasing aromatic content at constant saturate level results in increased road performance of the ternary blends in all cars.

4. With regard to road appreciation, the ternary blends vary—as did the binary blends—according to changing aromatic (or olefin) percentages.

5. Road appreciation is also related qualitatively to fuel sensitivity.

6. The hydrocarbon-type effect is most notable at high engine speeds in all of the test cars.

Results of the long-range program are made available to the refiner as the data are analyzed and reported.

Over-all Research Program Continues

These research findings are but another step forward in Ethyl's continuing effort to aid the refiner in blending fuels and predicting road performance without extensive road testing.

Right now, the long-range program is being carried forward to include all of the hydrocarbons falling within the gasoline boiling range. The results obtained in this important phase of the program will be made available for study by refiners in the near future.

How Ethyl Research is helping you

At today's high octane levels, the art of blending hydrocarbons has taken on ever-increasing importance. As a service to the Petroleum Industry, Ethyl Research launched its long-range hydrocarbon blending program in 1956 to complement the intensive Industry effort being devoted to the problem.

Since the program started, Ethyl has made available four technical reports: "Octane Possibilities with C_7-C_8 Hydrocarbons," "Octanes That Count," "TEL, Hydrocarbons and Road Appreciation," and "Road Performance of C_7-C_8 Blends via Computer Analysis."

Now a fifth report, "Road Performance of Ternary C_7-C_8 Hydrocarbon Blends," is available for your study. Copies of this—and any of the previously issued reports—can be obtained from your Ethyl Representative or by writing Ethyl Corporation, 100 Park Avenue, New York 17, N. Y.

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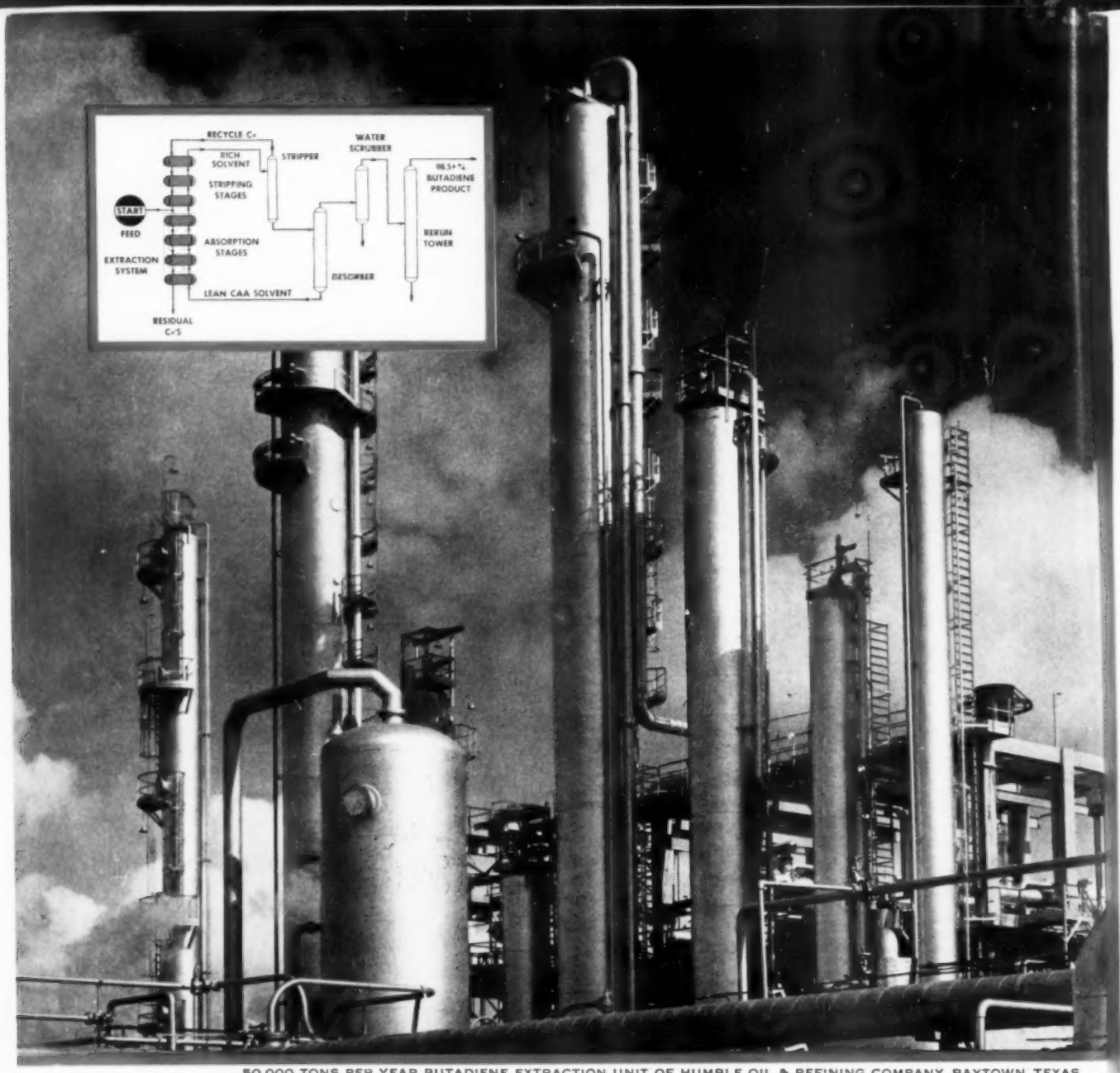

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Editorial and Business Offices:
330 West 42nd St., New York 36, N. Y.
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Dear Reader...

. . . We're going out of business! That's a rather brutal statement to have to make, but there's no easy way to say it without beating around the bush. This September, 1957, issue of PETROLEUM PROCESSING is the last one; publication of the magazine is being discontinued with this issue.

Since it was started in 1946, PETROLEUM PROCESSING has been providing you a quality product. Its editorial staff and content have both been of the highest caliber. We have been reaching a large and growing paid circulation of top-quality readers. In fact, our last circulation figure shows a total of 19,543. And the number of you who have been sending in renewals, which is a good barometer of what you think of the magazine, has been going up steadily.

Nevertheless, we have not been able to provide this service on a commercially profitable basis, nor do we see an early prospect of being able to do so—without sacrificing our high standards. We could, of course, cut costs by reducing the editorial staff, curtailing its extensive travelling for on-the-spot reporting, resorting to more "hand-out" and contributed material, doing less careful editing, using cheaper paper and printing. But these moves would not provide the quality service you have a right to expect.

Therefore, management has decided that it can best serve your interests by using the resources now being expended on PETROLEUM PROCESSING to expand the other McGraw-Hill publications already serving the petroleum and chemical fields.

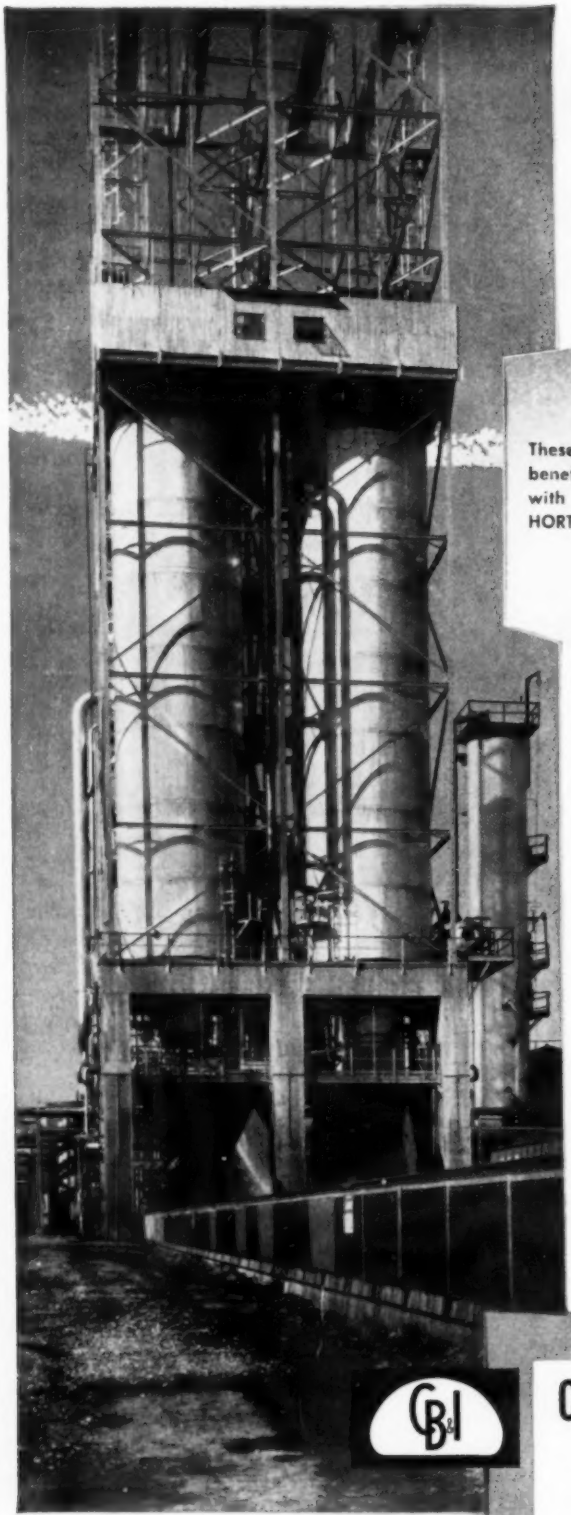
A lot of you still have subscriptions with many months to run. Those of you who we believe will be benefited by some of the other McGraw-Hill magazines will shortly be offered a dollar-for-dollar exchange for the unexpired balance of your subscription—or a cash refund.

We aren't simply dropping dead, of course. Even after the decision to kill PETROLEUM PROCESSING had been announced, the staff continued to edit and put together our 6th Annual Petrochemical Report for this issue. And I think it's the best Petrochemical report we've ever done—bar none. It's a credit to them that they had the fortitude, the stamina, the willingness to stick and do the best job they could—even while we were preparing the corpse for burial.

On behalf of myself and the entire staff of PETROLEUM PROCESSING, I want to thank all of you for the cooperation and support you have given us in the past. I sincerely hope our paths will cross in the future—and permit us to renew our pleasant relationships.

William F. Bland

—Editor



405 STAINLESS STEEL HORTONCLAD was used in the fabrication of these two 16-ft. diam. by 65-ft. high coking chambers by CB&I.

P-52C

HORTONCLAD®

(manufactured by vacuum bonding process)

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In corrosive service, Hortonclad permits the use of higher temperatures, concentration and pressures—without the high cost of solid alloy vessels. For further information on its application write our nearest office . . . ask for the *Hortonclad* bulletin.

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WHAT'S HAPPENING

In refining

. . . **Standard of California** is re-examining its plans for a refinery on Sand Islands in the harbor of Honolulu. Two years of frustration ending in government red tape may result in the refinery's construction on U. S. west coast.

. . . **Military will cut oil buying,** but published estimates of 10-15% (a cut of $115 to 170 million) are only arbitrary guesses. Aviation fuels and Navy special fuel oil purchases may be hardest hit. Small refiners, however, will retain their 4-million bbl set-aside, possibly winding up with a larger-than-originally-granted percentage of supply.

. . . **Small business set-aside** for JP-5 has been cut by the Military Petroleum Supply Agency to 10.5 million bbl.

. . . **Refinery man-days** lost because of strikes during 1957 should be substantially above the 90,400 lost last year. The 1956 figure, representing almost 0.2% of total man-days of worktime, is nearly double 1955's 43,400 man-days.

. . . **Continental** has completed its new 3300 b/d cat reforming unit at the Denver refinery. A $1.4-million program has brought refinery capacity up to 11,000 b/d.

. . . **Leonard Refineries** will add a $3-million, 7500 b/d Fluid cat cracker to its Alma, Mich., refinery. Parsons will build for August 1957 completion. A $1-million, 6-in. pipeline will carry 12-15,000 b/d 43 mi. from Alma to Lansing.

. . . **Standard of Indiana** will add a 1630 b/d hydrofluoric alkylation unit under Phillips license at its Mandan, N. D. refinery. Foster Wheeler will build for a Sept. 1958 onstream date.

. . . **American Petrofina of Texas** will add a cat reformer, hydrofluoric alkylation unit, and related facilities in a $3-million move to expand its newly purchased refinery at Mount Pleasant, Tex. Probable completion date: early 1959.

. . . **Gulf** will build a 12,000 b/d pentane isomerization unit at its Port Arthur refinery that will use UOP's Penex hydroisomerization process.

. . . **Esso Standard** has processed its two-billionth barrel of crude at Baton Rouge. The first billion bbl took 37 years—from 1909 to 1947. The second billion went through in 11 years. And at Bayway, Esso's 82,700 b/d Model III Fluid cat cracker is operating at a feed rate of more than 100,000 b/d, to become the first unit of any Jersey Standard affiliate to reach that figure.

. . . **Ashland Oil's** $10-million refinery expansion program, which has already brought cat reformers onstream at its Canton, Ohio, and Buffalo, N. Y. refineries, will also add a Udex unit early next year at Buffalo, and an asphalt unit for additional capacity at Canton.

. . . **Canadian Oil Cos.'** is studying a 20,000 b/d capacity boost for its 30,000 b/d Sarnia, Ont., refinery. A petrochemical unit was completed there in June.

. . . **Cities Service Oil Co., Ltd.** has started building its $27-million, 20,000 b/d refinery at Bronte, Ont. After completion of Cities' plant in Jan., 1959, and a proposed Shell refinery on an adjacent plot, there will be four refineries on Lake Ontario's north shore. McColl-Frontenac's at Regent, and B-A's at Clarkson are the other two.

. . . **Davison Chemical Co., Ltd.'s** new $6-million fluid cracking catalyst plant is now in full operation at Valleyfield, near Montreal, Canada. (See p. 198 for photo.)

. . . **Phillips'** 1200 b/sd Fluid cat cracking unit is nearing completion at Great Falls, Mont. The Procon-built unit was prefabricated at Des Plaines, Ill., and shipped to Great Falls.

. . . **Cities Service,** which has increased its asphalt sales by about 50% since 1954, will substantially boost production at Linden, N. J. by replacing its present 15,000 b/d plant there with a 20,000 b/d refinery capable of handling widely varying crudes.

In demand, stocks, trends

	1957 to Aug. 16	1956 All Aug.	% Change
Runs to stills	7.982	7.994	— 0.2
Demand			
Gasoline	4.283	4.113	+ 4.1
Middle dist.	1.310	1.362	— 3.8
Residuals	1.342	1.419	— 5.4
Stocks			
Gasoline	172.136	175.571	— 2.0
Middle dist.	179.724	170.850	+ 5.2
Residuals	50.923	46.783	+ 8.8

(Figures are in million b/d, API data)

For more details, turn to p. 217 this issue.

What's happening (continued)

More industrial than paving asphalts will be made.

. . . **An asphalt plant** has been proposed for the Savannah, Ga., area. A Canadian investment firm is principal backer of the project.

In petrochemicals

. . . **Butyl tires** are making news. On the heels of the Army's announcement that it will use the Esso Research-Mansfield Tire & Rubber Co. jointly developed all-butyl heavy duty truck tire, Firestone made public its experimental synthetic tire. Firestone's entry, made of coral rubber, is being examined by the Army's Ordinance Depot. Esso is continuing development of its isolefin-diolefin polymer MD-551, a quick vulcanizing, heat and flexing resistant rubber that is compatible with other rubbers, including GR-S.

. . . **"Vinyl," "acrylic," and "alkyd"** have been measured for consumer recognition. The Princeton research firm of Gallup & Robinson found that 61% of adult Americans recognize "vinyl," with 53% being able to name at least one product using it. Only 18% heard of "acrylic" and "alkyd."

. . . **Gulf will have Procon** build a 30-million gal/yr benzene plant on the site of its Porth Arthur, Tex., refinery. Completion is set for late 1958.

. . . **California Ammonia Co.** has started building a 100 t/d anhydrous ammonia plant at Lathrop, Calif. Natural gas will be the hydrogen source.

. . . **Swan-Finch Oil Corp.** may not be allowed to sell its petrochemical division to Michigan Chemical Corp. now that it has gone into receivership.

. . . **Hercules Powder's** 30-million lb/yr low-pressure polyethylene plant, first full-scale Ziegler-process installation in the U. S. is on stream at Parlin, N. J. so is Kopper's Woolridge, N. J. plant. When other projected plants are completed, including Union Carbide's Seadrift, Tex., and Institute, W. Va., plants, and a projected National Petrochemicals plant, 1960 capacity of low-pressure polyethylene should come close to 600 million lb/yr.

. . . **Platte Chemical Co.** will build a $2.5-million, 225 t/d sulfuric acid plant in Casper, Wyo. Davison Chemical also has plans for a sulfuric plant, a $2-million installation to be built by Leonard Construction in the same area.

. . . **Monsanto** will have Catalytic Construction engineer and build a methyl and ethyl parathion plant (for insecticides) on an accelerated basis at Anniston, Ala.

. . . **Spencer Chemical Co.** will build a 100 t/d urea plant at its Henderson, Ky., works. The plant, to be completed by next summer, will convert ammonia to urea-type solutions and prilled solid urea. Spencer's 10,000 t/yr Vicksburg, Miss., works is now in production.

. . . **National Petro-Chemical Corp.** will build a 75-million lb/yr conventional polyethylene plant at their Lake Charles, Port Neches, or an unspecified third location. Completion is scheduled for late 1958. The company also has plans for a polyvinyl chloride plant to be built in a joint venture with other companies.

. . . **Dow Chemical Co.'s** Texas Div. will start building an acrylonitrile plant at Freeport, Tex., for December 1958 completion.

. . . **Stauffer Chemical Co.** will build a 400 t/d sulfuric acid regeneration plant at Hammond, Ind., that will process refinery sludge. Full production of the highly automated, $4-million plant is expected to be reached by July, 1958.

. . . **The Consolidated Chemical Industries Div.** of Stauffer is starting to double capacity of its Baytown, Tex., sulfur recovery plant. The adjacent Humble refinery will provide basic feedstock.

. . . **Phillips Pacific Chemicals** $15-million Coulee ammonia plant near Kinnewick, Wash., is now in production, turning out about 200 t/d of ammonia and aqua ammonia from natural gas.

. . . **American Synthetic Rubber's** Louisville plant now produces at a 69,000 long t/yr rate after a $3.5-million expansion program. Pre-expansion capacity was 44,000 long t/yr.

In gas liquids recovery

. . . **Cotton Valley (La.) Operators Committee** will spend about $3 million expanding and modifying its gas cycling and extraction plant there. Three goals of the work, which has just started, are production of ethane, a 50% increase in propane recovery, and an almost 100% recovery of heavier hydrocarbons.

. . . **Wiseco Processing Plant Inc.** is building a 150-million cu ft/d natural gas plant near Bridgeport, Texas, that will produce 220,000 g/d of liquid products. Completion is set for early next year.

. . . **Columbia Gas System** will build an $8-million, 170-million cu ft/d extraction plant at Kenova, W. Va., to provide liquid hydrocarbons for a $5-million fractionation plant the company is planning to set up at Siloam, Ky. Columbia hopes the $13-million complex will attract petrochemical producers to adjacent land it has optioned at the West Virginia site. Completion: Dec. 1958. The Kenova-Siloam plant will make about 157,500 g/d of propane and 50,400 g/d of butane. An ethane

Reaching For The Sky But
STILL TIED TO THE GROUND

Reaching for the sky, this modern jet plane is dependent on the nation's refineries to provide the specialized fuel that is needed to get them there. In 1957, for example, it is estimated that jet fuel requirements will increase by approximately 12 per cent.

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Polyrad, a filming amine that acts as an inhibitor and detergent, helps maintain throughput, increase heat transfer, and cut down time for maintenance. At turn-around time you see the difference that Polyrad makes.

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NA57-4

What's happening (continued)

production of about 357,000 g/d is possible "some time in the future."

In foreign operations

EUROPE . . . Union Carbide has formed an Italian company, Celene, S.P.A., with Societa Edison, of Milan to produce and market high-pressure polyethylene from a projected 24-million lb/yr plant. Union Carbide will also build a 45-million lb/yr plant for the production of ethylene oxide derivatives at Fawley, England. Esso's nearby refinery will provide ethylene. UCC's Grangemouth, Scotland, polyethylene plant will go into production next month. . . . **ENI, the Italian oil monopoly,** is moving into Sicilian sulfur operations, and may possibly build a refinery there, as well . . . **BP Benzin-und Petroleum-Gesellshaft** will build its $83-million, 80,000 b/d refinery near Dinslaken, Germany. . . . **Societé des Produits Chimiques D'Aquitaine** will build plants in southwest France to make acetylene, methanol and ammonia from local natural gas. . . . **Jersey Standard** is delaying building of its proposed $30-million, 40,000 b/d refinery in Norway because of site selection difficulties. . . . **Compagnie Neerlandaise de l'Azote** has put its Sluiskil, Netherlands, urea plant into operation. Its fifth ammonia installation is about to go onstream. . . . **The A. Johnson & Co.'s** Nynashamn refinery, north of Stockholm, is now being expanded and modernized by Bechtel. A 6800 b/d cat reformer will help up capacity to 28,000 b/d. . . . **Rumania and Hungary** will be connected by a 220-mi pipeline that will carry 155 million cu ft/d of methane to northeast Hungary for polyacrylonitrile production.

FAR EAST . . . Shell Refining (Aust.) Pty. Ltd. will build a $1.2-million, 100 t/d sulfuric acid plant (Australia's first) at Geelong for late 1958 startup. . . . **Godfrey L. Cabot and United Carbon Co.** will build a $4.5-million carbon black plant near Melbourne to produce 25-30 million lb/jr. . . . **Stanvac's** proposed $35-million refinery on Bataan's west coast has cleared the last hurdle, government approval, and will become the second American plant in the Philippines. . . . **Mitsui Chemical Co.** will build a $1.5-million plant to synthesize acetylene and methanol from natural gas in Nigata Prefecture. . . . **Wilshire Oil** is considering putting a refinery in Hawaii. . . . **Dow's and Kilachand Devchand & Co. Ltd.'s** polystyrene plant has started production in Bombay, India. The plant is owned by Polychem Ltd, formed by the two companies for this purpose.

ELSEWHERE . . . Quimbrasil, Química Industrial Brasileira S.A., will build a 3,600 t/yr phenol plant near Rio de Janeiro, Brazil.

. . . **Petrofina** has the Angola government's permission to build a 2,000 b/d topping plant in Angola to operate from local crudes. . . . **African Explosives and Chemical Industries'** Modderfontin plant in South Africa will be expanded first to produce 70,000 t/yr of ammonia, later to make 110,000 t/yr of urea.

In markets and prices

. . . **With one exception**—the big bright spot for gasoline is the Midwest—products were having their price troubles in practically all other wholesale (and many retail) markets in the country during August.

The Middle West, meanwhile, was enjoying one of the best summers for gasoline in history. Shippers in the Great Lakes Pipe Line system said the line handled a record volume of gasoline in July and shipping capacity was being taxed to limits all during August. In fact, many shippers were short of gasoline and were shopping around to get product into their upper-Midwest marketing areas by barge, tank car and transport truck.

The tightness in gasoline that came about at many of the GLPL terminals went a long way toward correcting the unseasonal 0.75¢ price cut of late June.

Late in August, an oversupply condition in residual fuel at Philadelphia created disturbances that had Gulf Coast, Caribbean, East Coast and even European refiners wondering about the fall outlook for bunker oil prices.

Foreign-flag tanker owners were interested in backhauling this low-cost resid to Europe. On their way back to the Middle East for their crude cargoes, anything these tankers pick up in way of cargo cash is better than hauling sea water ballast for nothing.

In transition

. . . **Eastern States Petroleum Co.** is changing its name to Eastern States Petroleum & Chemical Corp., because of its increasing petrochemical activity. The firm will also add xylene isomers, ethylbenzene, cyclohexane and other chemicals to its line.

Here and there

. . . **U. of Illinois researchers** have proved that oil is colloidal, as long suspected. Illinois crude, after being ultracentrifuged at 80,000 G for extended periods, separated in distinct phases. The colloid particles are made up of clays, asphaltenes, and maltenes.

. . . **Fast tax write-off program** will be completely over by the end of 1959. As of now, only the most essential-to-defense projects will be given tax amortization certificates. Most oil industry write-offs have already been suspended.

BENCH-SCALE DISTILLATION EQUIPMENT. The Center has various types and sizes of apparatus to distill any size sample from one cc to a tank-car load.

Unique Lummus Engineering Development Center—30 Minutes From Manhattan—Proves Out Processes Before Construction

At a new 150,000 square-foot Center near the Newark Airport, the Lummus Company is expanding a long-established engineering development program into a major service to the process industries. The intensive pilot plant investigations carried out here will, in the years to come, spell the difference between rash gamble and sound plant investment for many manufacturers in the chemical, petroleum, pulp and paper and allied fields.

For a complete description of The Center and how it can help you bridge the gap between laboratory research and successful production, write for the 16-page brochure "Lummus Engineering Development Center." Address The Lummus Company, 385 Madison Avenue, New York 17, New York.

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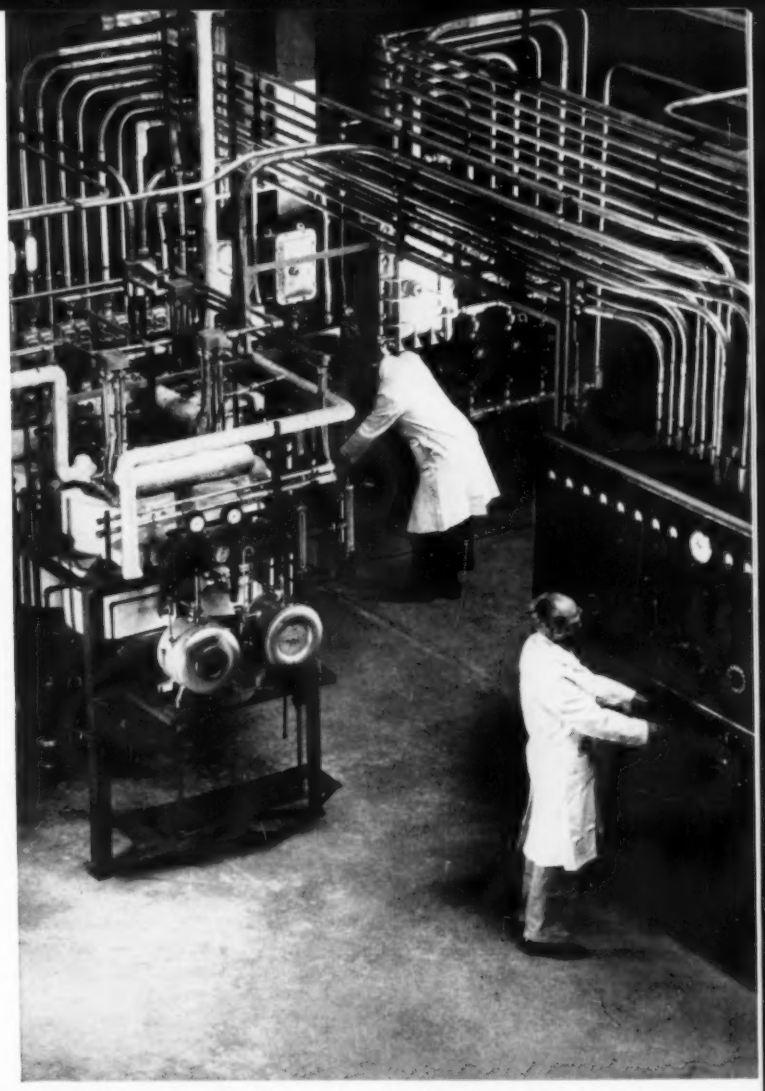
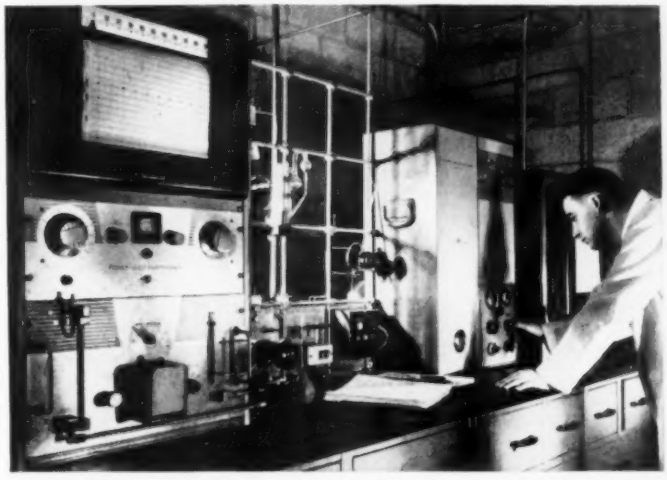
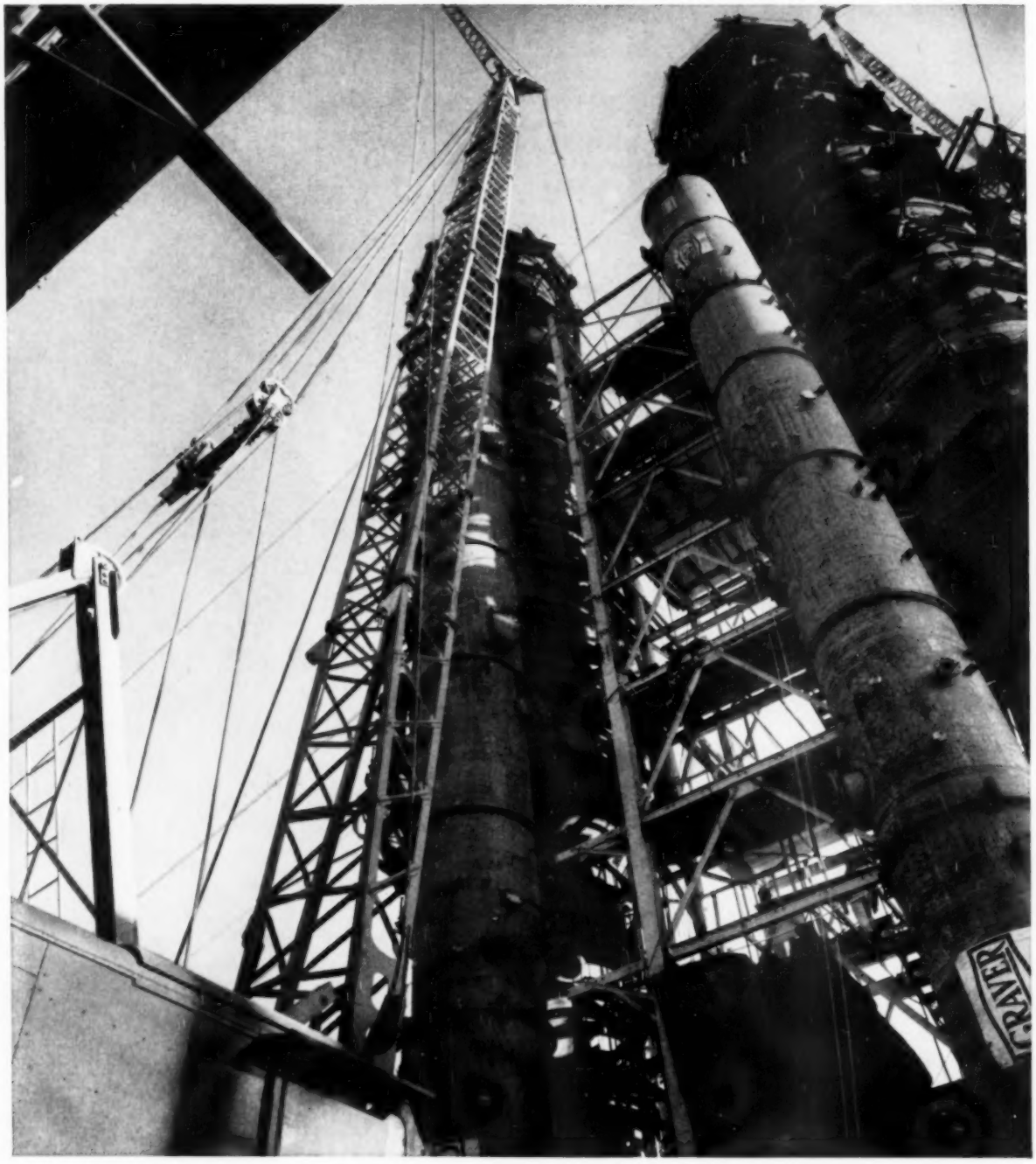


MOST PILOT UNITS at The Center are put together from standard "building blocks." Skid-mounted charging units such as the one at left hold tanks, heaters and pumps for transfer and metering. Process equipment, here shown in background center, can be widely varied. At right is electrical control cabinet. All switches, relays and controls not housed in explosion-proof boxes are enclosed in cabinets like this one, pressurized with outside air to exclude process vapors.



ANALYSIS OF MATERIALS processed and produced in pilot operations at The Center is an important part of the work carried out by Lummus engineers. Here a laboratory technician determines the composition of a multiple-component gas, using a gas chromatography technique.



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 (To obtain more data on advertised products see page 222)

Radioisotopes in refineries: a look into the future

WHETHER RADIATION PROCESSING comes or not, the age of the radioisotope is a sure bet. We asked oilmen, people in the Atomic Energy Commission, and supplier firms to describe the shape of this radioisotope future. Here is how they saw it.

1—The growth of the atomic energy industry itself is the all-important background. Research and power reactors may be common sights in a few years—located within hours of any process plant. The small, comparatively inexpensive research reactors now entering the market may prove attractive to even small companies as sources of neutrons and radioisotopes. Accelerators, as they grow cheaper, may find wider use in labs and plants.

Thus, the supply of radiation for all purposes will greatly increase, and radioisotopes should be cheaper and available in larger quantities.

2—One result is that short-lived radioisotopes will find greater use—because they reduce the danger of lasting radioactivity. You can use one in a process, or for leak detection in the plant, and be able to ship the product or use the area in a matter of hours. The lives of many of these are too short for general use today, but if reactors are nearby, or within the plant, many new radioisotopes will be practical to use. They may be in routine use for locating leaking valves and heat exchangers and for checking the performance of packing glands, pumps, and valves.

3—"Increasing sensitivity and versatility of commercial counting equipment are expanding tracer applications," write V. P. Guinn and H. R. Lukens, of Shell Development Co. More sensitive detectors reduce the quantity of radioisotope needed for a job. Also, they say, "the advent of reliable and inexpensive multichannel spectrometers permits analysis of mixed activities" in tracer work and activation analysis.

Jerry Kohl, of Tracerlab's Western Division, gives transistors credit for making possible the development of "small, lightweight portable instruments free of explosion hazards and particularly suitable for refinery use." They have also improved the accuracy of backscattering density gages, which are used to measure thickness and locate solids in a line.

4—What about future applications? Some foresaw radioisotopes being used in petroleum process control, as they are in other industries (e.g., cigarette manufacture, where beta-gages control cigarette thickness; a cement plant, where a gamma gage controls asbestos cement-water slurry). A few such installations exist in the petroleum industry. They use a sealed, stationary source of gamma rays, and absorption by the process stream indicates the mixture of two substances of known density. The detector is linked to control apparatus.

More complicated systems are also anticipated. V. P. Guinn and H. R. Lukens believe it is possible even now to control several parameters of a process with a computer linked to a multichemical radioactivity analyzer, which could simultaneously measure different tracers in the process stream.

Telefluoroscopy, another intriguing idea, is possible with an X-ray generator today. But when radioisotopes are used instead the picture is badly blurred by scattered, reflected radiation. Actual refinery tests show also that prohibitively large sources must be used for refinery-size equipment. Even though one manufacturer (Bendix Aviation) is working to make the televised fluoroscope sensitive to smaller radiation sources, it may be some time before the scattering problem is solved and the operator can watch, say, the flow pattern in a cracker standpipe on TV in the control room.

Radiation in analytical work has an exciting future. George Manov, of the AEC, writes that instruments using the absorption principle already can be installed onstream for continuous monitoring of carbon-hydrogen ratio for, say, a cracking operation. Savings over the time-consuming combustion methods of organic analysis are considerable.

The same principle is embodied in a device, now leaving the laboratory stage, that measures total sulfur in hydrocarbons regardless of its form—H_2S, mercaptan, thioether, etc. It takes less than 5 minutes, Mr. Manov reports.

Most discussed, though, was the highly sensitive technique of activation analysis. Metals content, or several other things, can be measured in a sample by taking it to a reactor, having it bombarded with neutrons (which "activate" the metals), and analyzing its radioactivity. Another way is to measure the change in the reactor's activity when the sample is inside. The sample will absorb neutrons in proportion to its metals content. These methods will become routine, obviously, only if a reactor is nearby or in the plant, which refers us to point 1.

Tracer studies will certainly grow in scope. As L. P. Elliott, of California Research Corp. says, "Most companies have been slow to discover the powerful engineering tools tracers offer the study of processes. Mixing, distillation, entrainment, scrubbing, settling can be studied in the full-scale plant without upsetting operations."

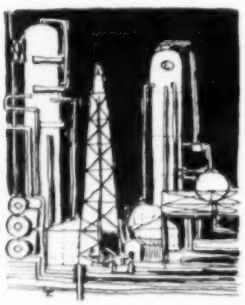
Portable, sealed sources are already routine in some plants for diagnosing plugged lines, thin places, bubbles, interfaces, etc. C. C. Swoope, of Esso Standard Oil Co.'s Baltimore refinery, says "This has saved countless sums of money and will continue to grow rapidly."

5. Have radioisotopes "caught on"? In a survey of U. S. petroleum and petrochemical plants by

PETROLEUM PROCESSING, only 28% of the respondents now use atomic radiation in any form. The surface has only been scratched. —S.D.B.

You may be sending your wastes down the drain tomorrow

DOWN the well, though, would be more accurate. Shell Chemical Co. is doing just that at its Houston plant where it has sunk a 7650-ft well to dispose of its waste products.



Other processors, with problems similar to Shell's may find drilling a convenient answer to a toughening problem. Shell, in the Gulf area where waste disposal is unusually difficult, where there are few usable dry holes, and a growing awareness of air-pollution hazards, had plenty of incentive for investigating the well technique.

Geological conditions were right—the below-surface sands passed the injected material fast enough, and were separated from the water table above it by 3000 ft and inpenetrable rock. This assured that the area's scarce fresh water supply would not be contaminated.

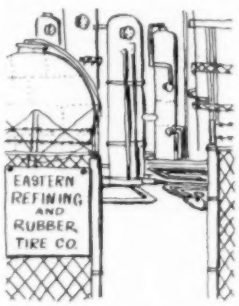
Though Shell spent about $166,000, other processors' costs would vary widely with the type of earth structure involved. But, it's one way out. Perhaps drilling rigs will become standard refinery equipment.

Will butadiene become a refiner's product?

REFINERS may soon be cutting themselves a larger slice of the growing butadiene pie. With capacity expected to top 1 million t/yr by 1959, butadiene is looking more and more attractive as a direct refinery product.

Some refiners are studying Houdry fixed-bed dehydrogenation installations in butadiene plants for possible inclusion in refinery operations. Several processors—Standard of Calif., Sun, and an Esso subsidiary—have licensed the Houdry process.

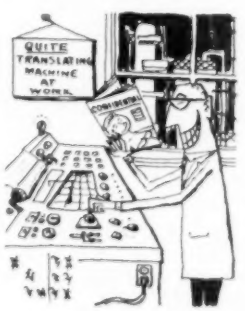
Butadiene production offers refiners: 1—a better market for normal butane, which is often in long supply, 2—another use for butylene, from which butadiene can also be made, and, 3—yield flexibility with the Houdry process permitting better alkylate economics. (When demand for alkylate feedstock declines, the isobutane and butylenes can be recycled to make more butadiene during dehydrogenation of normal butanes.)



Another possibility for the future is making butadiene in a fluidized-solid catalytic process. A Gulf coast refiner is considering building a fluid-type process for dehydrogenation of light hydrocarbons, probably butanes. (For more on butadiene see p. 110.)

Machine translation of languages now a step closer

EVER wish you could read the foreign-language literature of your technology? You may be doing so sooner than you think. A computer has been successfully programmed to translate small-vocabulary Russian, German, French, and Spanish texts into English.



An Hungarian refugee scientist was able to break through the language barrier by developing a semantic unit formula permitting interpretation of phrases and thoughts. Word-for-word comparison would have been simpler to handle but would not have provided sufficiently accurate information.

The next step is expansion of the 500-word vocabulary taped onto the magnetic memory drum of the Datatron unit. (Semantic and logical patterns, as well as glossaries, are stored in the drum.) The present 40,800-digit capacity of the memory unit will be increased to 200-million characters through use of an external multiple-tape unit.

Synthesis gas from cheap coal. An inexpensive substitute for natural gas in some applications may be in the cards. Synthesis gas (of carbon monoxide and hydrogen) has been produced from cheap coal in the pilot-plant operations at the Institute of Gas Technology in Chicago. The process—gasification of pulverized coal under slagging conditions at above-atmospheric pressure—produces gas that can be up-graded by methanation to fuel-gas quality.

A FLOATING ROOF IS ONLY AS SAFE AS ITS SEAL

SAFER

SAFER BECAUSE the design of the seal virtually eliminates critical vapor space—prevents collection of explosive air-vapor mixture, even in the broad range of jet fuels.

SAFER BECAUSE even in exposure fires if fabric is damaged, there is an all-steel, fire-retardant seal. In exposure fires, all-fabric seals burn out quickly, leaving no seal at all.

SAFER BECAUSE the fabric is protected by the Weather Hood against sun and the collection of rust and ice. Fabric never comes in contact with the tank shell and can be inspected easily at any time.

SAFER BECAUSE the floating roof is "grounded" to the tank by an electrical path which never passes through a confined air-vapor volume.

SAFER BECAUSE if boiling liquid due to external fire forces vapor up through shoe-shell slot, ignited vapor is confined to a small sector. If unburned liquid is forced up, the Weather Hood prevents it from falling back onto the fabric.

SAFER BECAUSE the possibility of fire originating within the seal is reduced almost to zero. Even when the air-vapor mixture is test-ignited, pressure during burning is held to atmospheric. Fabric *instantly* flexes upward—expanding 300% to 500%—containing the products of combustion without damage to the fabric.

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RIDGID
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Petroleum Processing

LETTERS

What about asphalt specs?

To The Editor: I just received my June issue of PETROLEUM PROCESSING. The article "The Asphalt Debate is On" (p. 65) is good and timely.

The specifications used by each state are very general. Their effect is not to exclude an average asphalt that would have passed the ancient rule-of-thumb tests. Any asphalt, good, bad, cracked, or made from acid sludge, might pass these general specs, and some have in many states. . . .

. . . We need, as Mr. R. Linden of Union Oil Co., mentioned on p. 66 of your article, "to develop and adopt new specs that will . . . define quality." Present specs in use, those of the individual states and of the Asphalt Institute, do not do this. Simplifying the number of grades will not prevent the problem of good and bad asphalts being lumped together. This is the crux of the situation.

E. J. Barth

Consulting Engineer
New York, N.Y.

One more process

To The Editor: We were disappointed to see that in your Refining Process Glossary of your May issue of PETROLEUM PROCESSING you left out our Liquid-Phase Butane Isomerization Process. We are unhappy about the omission because of the industry's current active interest in butane isomerization, and especially because we consider our liquid-phase process generally superior to the vapor-phase process we license, or the processes licensed by others.

G. E. Liedholm

Shell Development Co.
Emeryville, Calif.

• *Thank you, Mr. Liedholm, for calling our attention to this fact. The description in question will certainly be included in future editions of this glossary.*

Congratulations

To The Editor: Congratulations on the 1957 Award of Merit that *Industrial Marketing* gave your publication for the special report on "Hydrogen Processing." It was truly a "monumental

job" as you have stated in your editorial (p 7, June '57). Although I am a refinery maintenance man, I read the report through if for no other reason than to have a speaking acquaintance with the processes and terms, many of which we already are, or shall be, using in our refining operations.

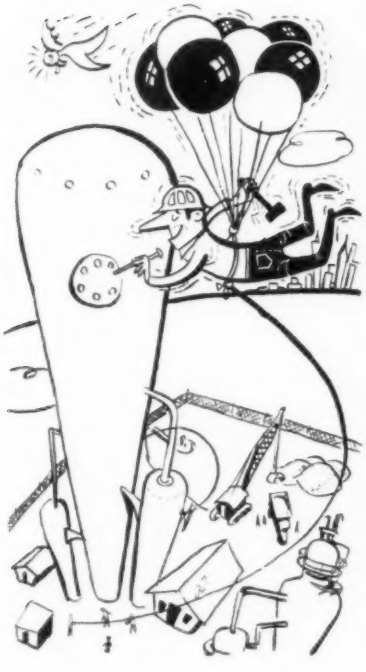
Please convey my sincere gratitude to your Associate Editor Bob Davidson for having completed such a thorough and complete study, and then for having put it in an interesting and readable form so that a maintenance man would like it and understand it. Surely you must have detached Bob and put him in an "ivory tower" with nothing else to do while he was doing all that searching of the literature and patents, plus conducting a multitude of interviews.

C. C. Carmine

Supervisor of
Maintenance and Construction
Tidewater Oil Co.
Associated, Calif.

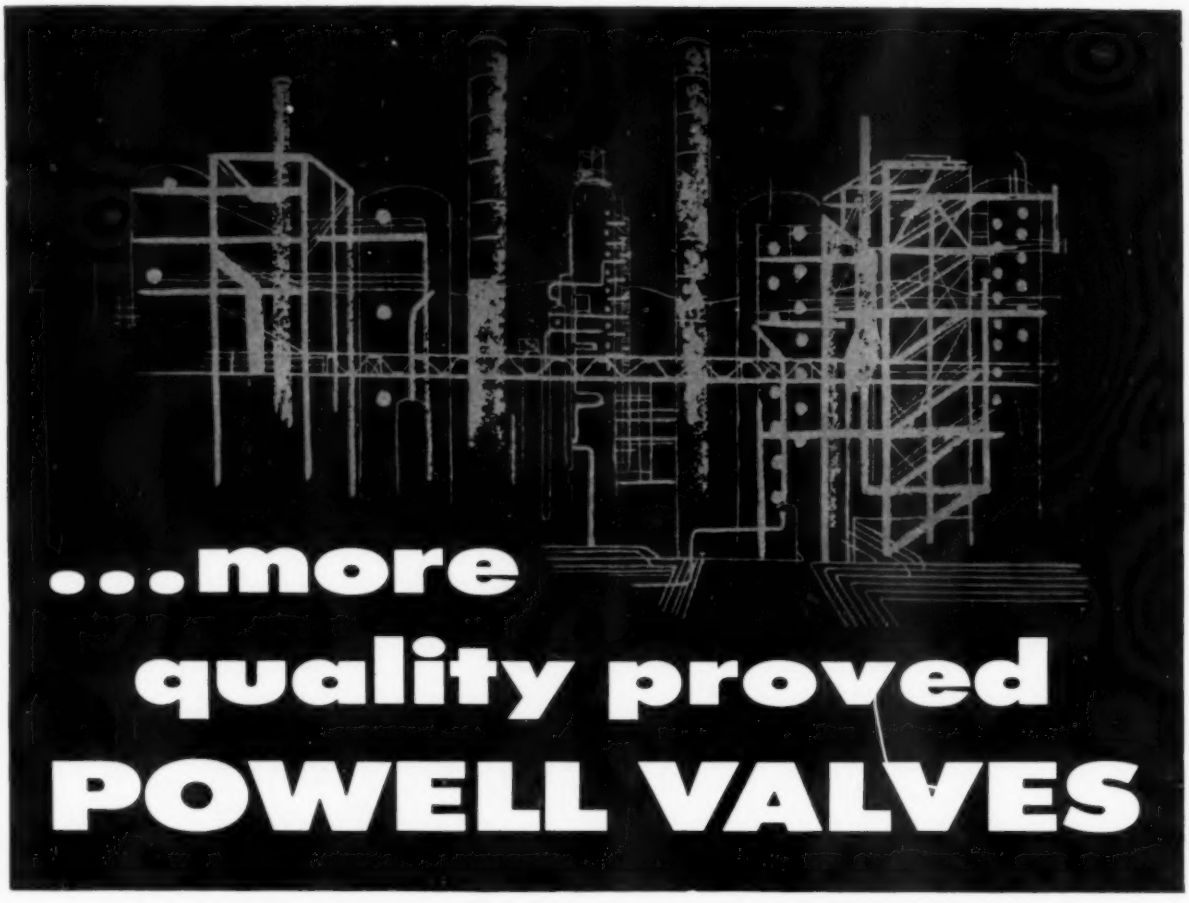
● *Thank you, reader—and author—Carmine (M&C panelist). However, "Hercules" Davidson did not occupy any ivory tower. He carried on almost all his routine chores for the magazine simultaneously with the special report project.*

• • •



14"
Fact 1
Once in a while a better product is made, and made so well, that it becomes the standard by which all similar products are judged.
RIDGID
HEAVY DUTY
Every RIDGID Pipe Tool TESTED individually before shipment
Fact 2
The preference that you and millions of other users have shown for the RIDGID Pipe Wrench puts on us the responsibility of keeping it always up to the top quality you expect of it.
The Ridge Tool Company, Elyria, Ohio, U. S. A.

 (To obtain more data on advertised products see page 222)



...more quality proved POWELL VALVES

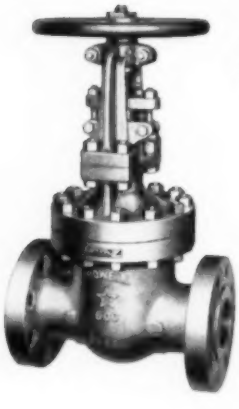


FIG. 6003 SS—Alloy Steel Gate Valve for 600 Pounds W.S.P.

FIG. 3061—300-Pound Steel Swing Check Valve.

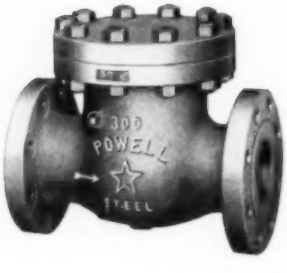


FIG. 1563G—Gear Operated Lubricated Plug Valve, 150 Pound Steel.

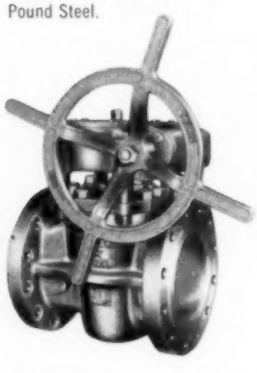
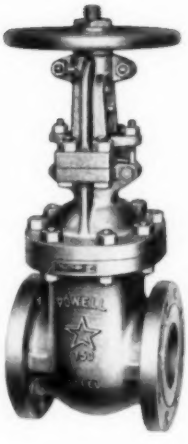


FIG. 1503—150-Pound Steel Gate Valve.



Designed for long life, designed for dependable service

Consult your Powell Valve distributor for all the facts about quality proved bronze, iron, steel and corrosion-resistant valves. For every flow problem . . . there is a Powell Valve to solve it.

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

What's your tubing problem?

corrosion?
damage?
installation?
fire? cost?

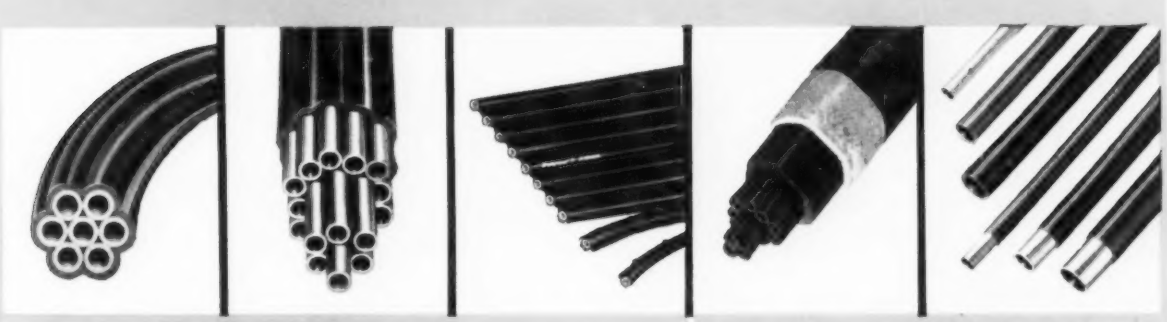
Wherever instrument tubing is used—be it refinery, natural gasoline plant, chemical, nuclear or food processing—Dekoron Tubing Products can help whip your ultimate twin problems of *maintenance-replacement expense and installation costs.*

Why?

First, because Dekoron Tubing products resist chemical attack and corrosion caused by moisture and industrial atmospheres. That means that once installed, Dekoron products are in to stay. You're not faced by perennial replacement and maintenance costs.

Second, the big savings in cost are yours in installation when you specify multiple-line Dekoron products—you install many instrument lines at once.

So if you have an instrument tubing problem of *any sort*, we probably have the answer *in stock*. If not, we can design and make it for you.



POLY-COR
From 2 up to 37 plastic tubes in plastic armor.

METL-COR
From 2 up to 19 copper or aluminum tubes in plastic armor.

RIBBON
M-Ribbon (metal) and P-Ribbon (plastic). 10 tubes in plastic sheath.

PROTECTO-PAC
Fire and impact resistant. Plastic tubes covered with plastic-asbestos-plastic armor.

SINGLE-LINE
Single steel, copper or aluminum tubes in plastic armor, or all-plastic tubing.

Dekoron® products
QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & CO.
Dekoron Products Division
MANTUA, OHIO

SEE DEKORON TUBING PRODUCTS ON DISPLAY AT THE CONVENTION **BOOTH 1017**

AA-6008

stop condensate backup

Nicholson steam traps discharge condensate and air from steam lines and equipment *faster* than any other trap of comparable size . . . help you make full use of your steam dollar. The reason—the effective use of a large orifice. A ½" Nicholson trap has a greater discharge capacity than most 1¼" traps . . . and costs less, too!

And that's not all. With just one thermostatically-operated moving part, there's nothing to get out of order, nothing to go wrong. Nicholson means continuous and low-cost operation of your steam-using equipment . . . no downtime from trap failure.

- **powerful valve action . . . no mechanical linkages to cause trouble.**
- **small and lightweight . . . easy to pipe and support.**
- **each unit steam-tested before shipment.**

So, to get a trap that discharges faster, saves money, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA. *Sales and Engineering offices in 98 principal cities.*

Write for Bulletin 1055

NICHOLSON
of Wilkes-Barre

ISOFLOW FURNACES NOW PROCESSING 300,000 b/d IN CATALYTIC REFORMERS

. . . and more "Isoflows" are being installed in the largest reformers under construction

The continuous production of high octane gasoline by catalytic reforming demands sturdy, efficient, soundly designed equipment. This is especially true of furnaces.

The wide acceptance of Petrochem-Isoflow furnaces is due to their high efficiency, dependable performance even under overload conditions, and their long service life. When you apply all the specifications and operating requirements to direct fired furnace design you'll find Petrochem-Isoflows most economically desirable, by any comparison.

For petroleum, chemical and allied process industries there's a Petrochem-Isoflow furnace for any duty, temperature and efficiency.

The unique design and operating features which have led to the wide acceptance of Petro-Chem furnaces include:

- **Uniform Heat Distribution**
- **Maximum Fuel Efficiency**
- **Low Pressure Drop**
- **Low Maintenance**
- **Zero Air Leakage**
- **Minimum Ground Space**
- **Simplicity of Design and Construction**
- **Short Length of Liquid Travel**
- **Series, Multipass, all parallel flow**
- **Excess Draft for High Overload**

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

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PETROCHEMICALS

another broad field for UOP service to oil refiners . . .

In its business of developing improved refining processes for the oil industry, Universal Oil Products Company has long been vitally concerned with effective means of producing the valuable chemical products from petroleum. The great worth of these petrochemicals to our national economy is recognized by everyone. They are vitally important to the refining industry, too, if refiners are to maximize the value of products from crude oil processed through their plants.

In the interest of the oil refining industry UOP has recently established a program of petrochemical process and marketing development. Under this program any refiner, anywhere in the free world, regardless of the volume of his operation will be able to enjoy the economic and operating advantages which the production of the petrochemicals most suited to this operation can provide.

This new petrochemical program makes available to you, through UOP, a variety of petrochemical processes.

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UNIVERSAL OIL PRODUCTS COMPANY

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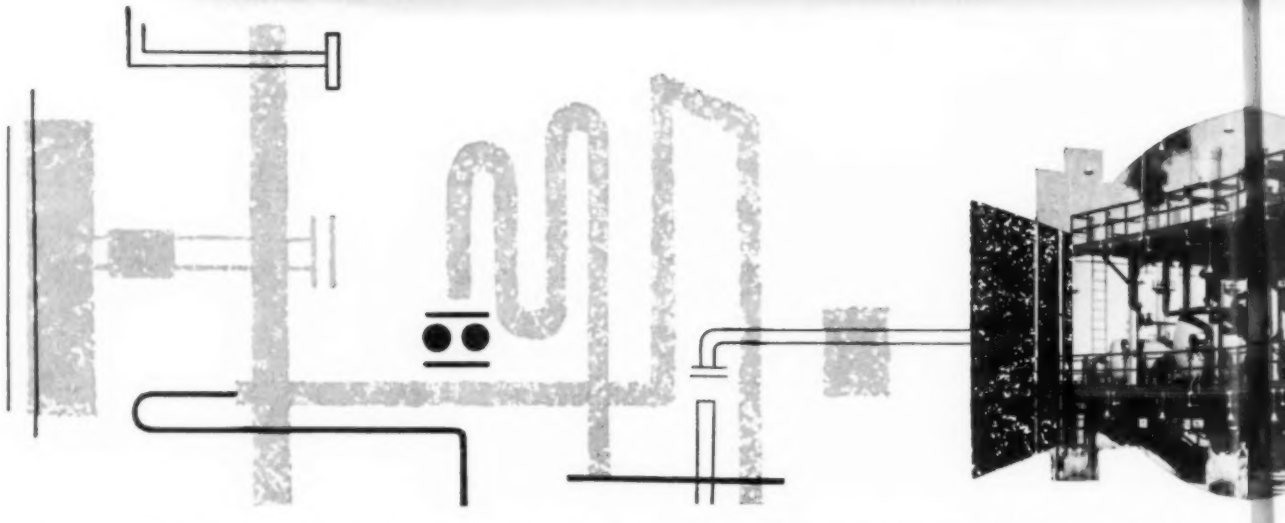
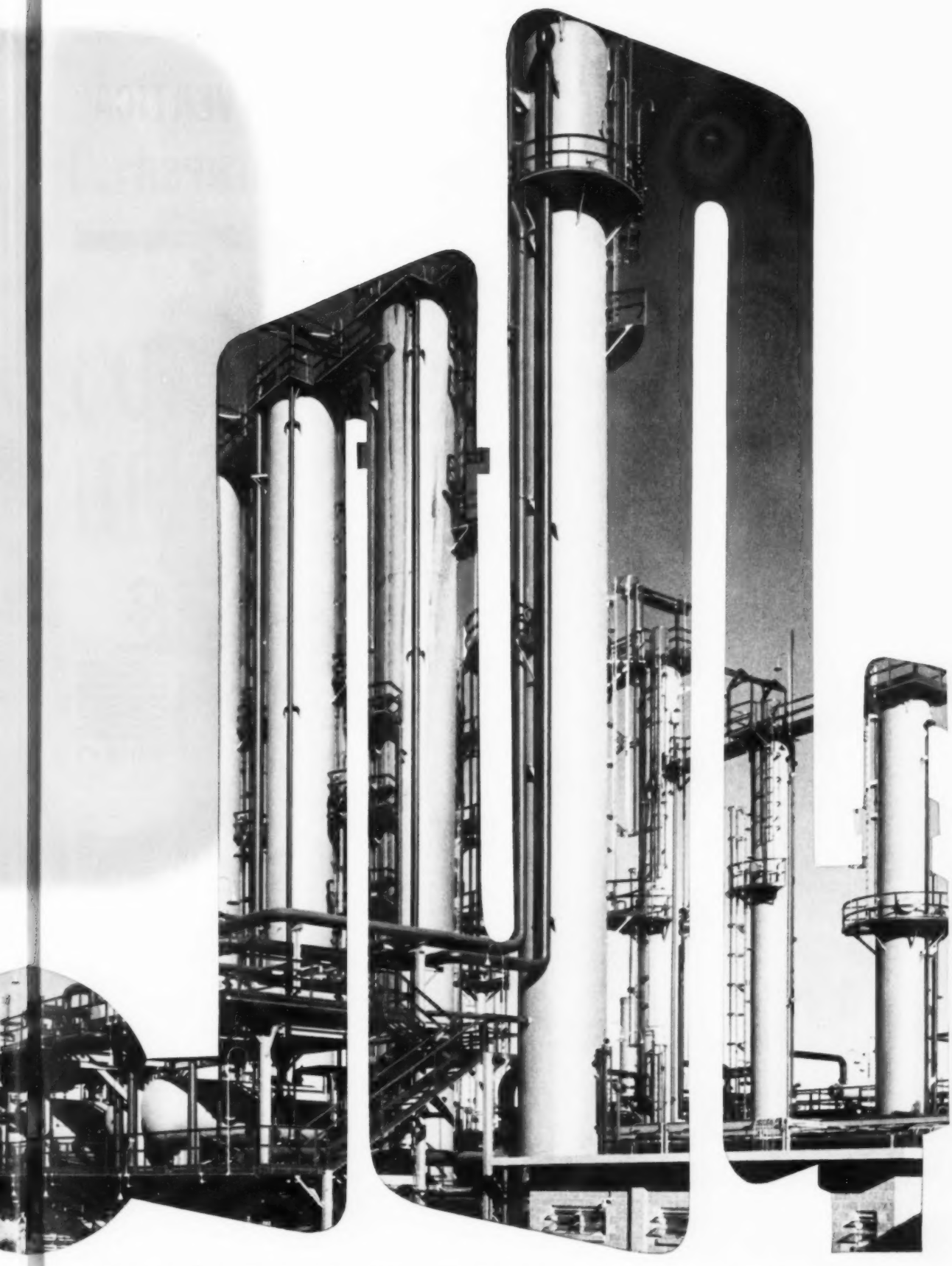
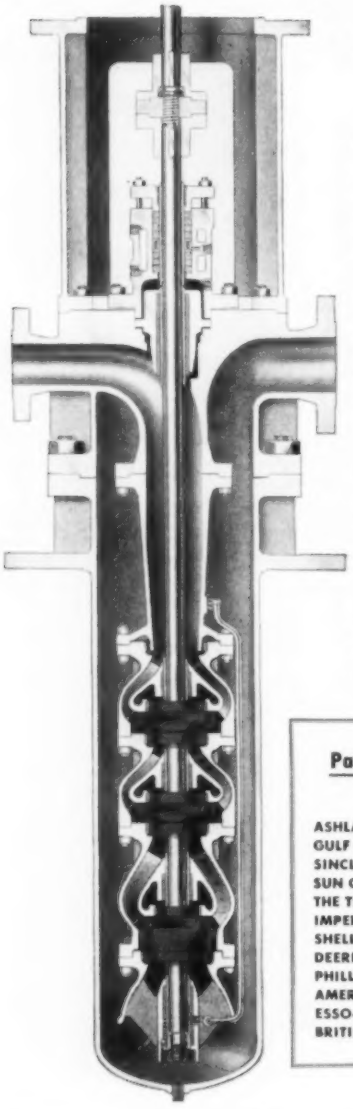
More Than Forty Years Of Leadership In Petroleum Refining Technology





NEW! Bingham VCP VERTICAL PUMP FOR LOW NPSH



ALL WORKING PARTS ACCESSIBLE WITH BOTTOM DISMANTLING

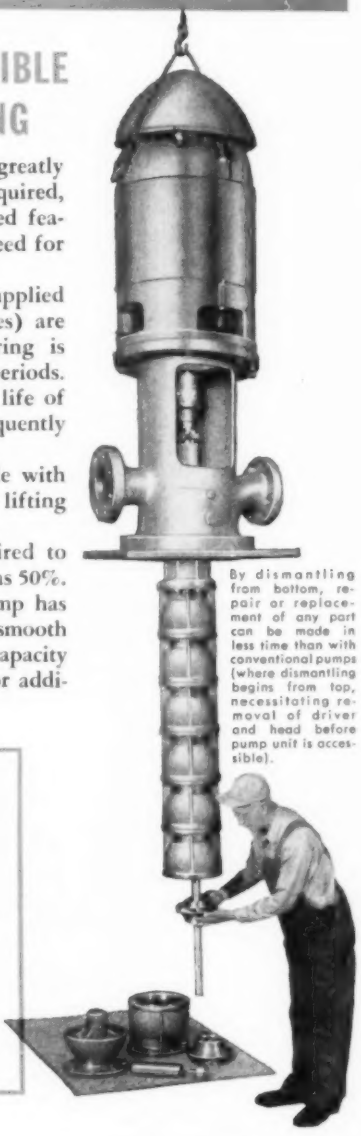
Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced features which minimize maintenance, reducing need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by pumpage. Bottom bearing is lubricated, even if pump runs dry for short periods. This *dependable* lubrication greatly prolongs life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

All working parts of pump easily accessible with bottom dismantling. One man can service after lifting pump from well.

Various operators estimate that time required to reach working parts has been reduced as much as 50%.

Wherever installed, the Bingham VCP Pump has given trouble-free service—plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information.



By dismantling from bottom, repair or replacement of any part can be made in less time than with conventional pumps (where dismantling begins from top, necessitating removal of driver and head before pump unit is accessible).

Partial list of major oil companies with Bingham "VCP" Pumps in operation or on order:

ASHLAND OIL & REFINING CO.	LAKEHEAD PIPE LINE CO.
GULF OIL CORPORATION	CREOLE PETROLEUM CO.
SINCLAIR OIL & REFINING CO.	HUMBLE OIL COMPANY
SUN OIL COMPANY	STANDARD OIL CO. OF INDIANA
THE TEXAS COMPANY	CHEMICAL CONSTRUCTION CO.
IMPERIAL OIL CO., LTD.	CHAMPLIN REFINING CO.
SHELL OIL COMPANY	PACIFIC GAS & ELECTRIC CO.
DEERE & COMPANY	SOCONY MOBIL
PHILLIPS PETROLEUM CO.	AEROJET GENERAL CORP.
AMERICAN CYANAMIDE CO.	GREAT LAKES PIPE LINE CO.
ESSO-STANDARD OIL OF N. J.	KANEB PIPE LINE
BRITISH AMERICAN OIL CO., LTD.	BUCKEYE PIPE LINE CO.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

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(To obtain more data on advertised products see page 222)

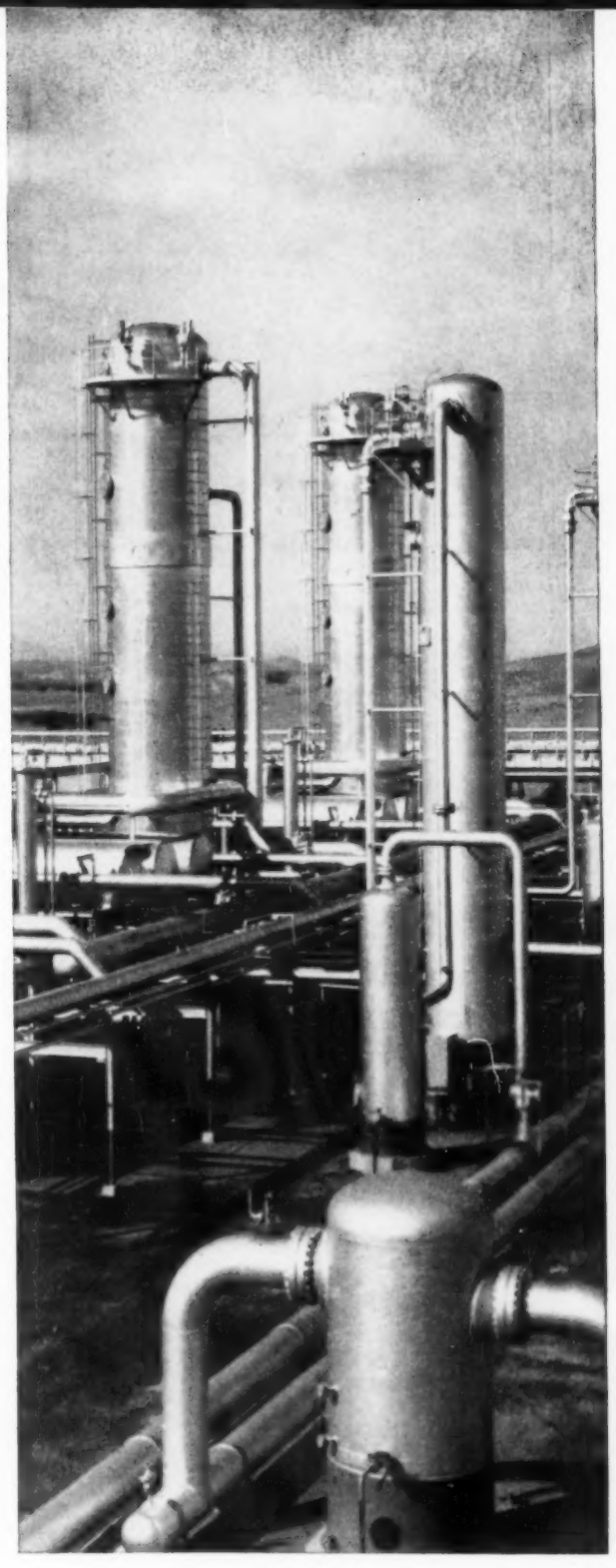
Performance-proved CURE for CORROSION HEADACHES

Specify Alcoa Aluminum for
• Process Equipment
• Transfer and Storage
• Plant Structures

Excessive maintenance and replacement of materials and equipment has fast become the biggest single headache in the process industries. Corrosion is far and away the most serious cause of such headaches. That's the big reason why aluminum—Alcoa® Aluminum—is daily being specified and installed in an increasing variety of uses throughout the process industries.

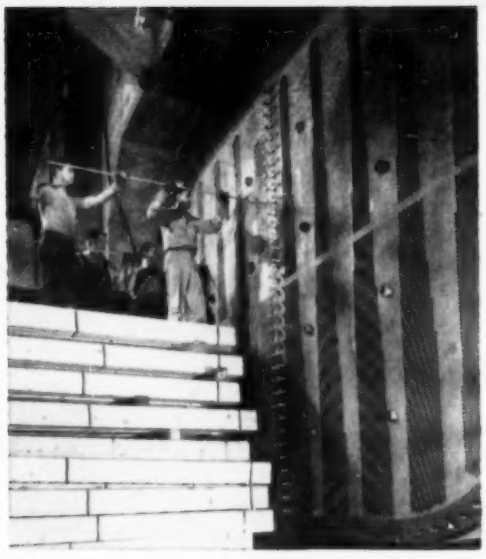
No other metal can match the ability of aluminum to resist successfully so many types of corrosive attack. And aluminum can be used to bring that unmatched corrosion resistance to a variety of applications . . . because only aluminum combines these *other* valuable properties in a single metal:

Light weight
Good workability
High thermal and electrical conductivity
Great strength in alloys
Nonmagnetic, nonsparking characteristics
Nontoxicity
Good reflectivity
Clean, attractive appearance
Low cost

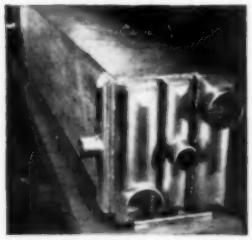


Study the next three pages to discover a few of the many process industries' uses of Alcoa Aluminum which insure outstanding metal performance . . . unhampered by corrosion. See why these various uses of aluminum have already helped hundreds of others . . . and can help you!

ALUMINUM COMPANY OF AMERICA



This brazed aluminum assembly, weighing nearly 900 pounds, is typical of exchangers used in air separation plants and other low-temperature exchange processes.



A 105,000 sq ft surface condenser with Alcoa aluminum heat exchanger tubes.

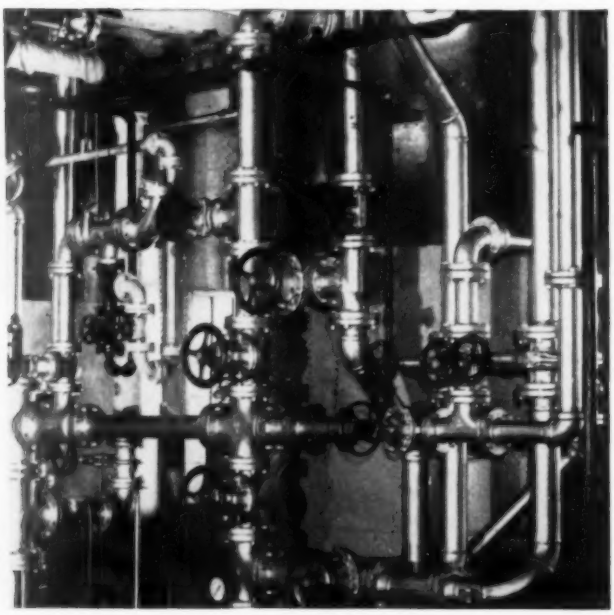
heat exchanger tubes

Aluminum heat exchanger tubes are low in cost, resist oxidation and other chemical attack, are easy to fabricate, have excellent thermal conductivity and freedom from embrittlement at low temperatures.

Aluminum tubes have demonstrated their ability to give long, dependable service under severe conditions. They are used extensively in exchangers for handling hydrogen peroxide, nitric acid, hydrogen sulfide, ammonia, naval stores, glycerine, scrylonitrile and other chemicals. Alclad tubes are recommended for use with natural cooling waters.

Aluminum costs approximately ½ the cost of admiralty, less than ⅕ the cost of stainless, and in the common ¾" and 1" sizes, less than mild steel.

Get detailed information on Alcoa aluminum heat exchanger tubes in booklet AD186, available on request.



Alcoa aluminum pipe proved ideal to solve corrosion and product contamination problems in this processing plant.

process piping

Corrosion resistant Alcoa aluminum pipe is widely used to carry liquids and gases in chemical, petrochemical, petroleum and food processing plants. It resists attack by the materials carried as well as by the corrosive atmosphere often encountered around such plants. And it prevents product contamination or discoloration.

Aluminum pipe is available in all of the normally produced schedules. It is by far the lowest priced corrosion resistant pipe available. For example, schedule 40 aluminum pipe is ¼ the cost of schedule 5 stainless, 1/7 the cost of schedule 40 stainless.

Write for *Aluminum Pipe and Fittings* booklet, AD197.

unitrace*

Alcoa now offers a new and improved design of Unitrace, the unique aluminum steam-traced pipe which incorporates the steam line as an integral part of the pipe. Extruded as a single unit of aluminum, from Alcoa 3003-F alloy, Unitrace is available in diameters equal to 1½", 2", 3" and 4" pipe.

Special cast Unitrace flanges and fittings are available in alloy A356-T6 for efficient joining of sections. In many installations, flanging is not required, as sections of Unitrace can be joined easily by welding.

Preformed insulation will fit Unitrace although thermal insulation is unnecessary in many cases.

For detailed information, write for Bulletin AD418.

*Registered trademark

New type Unitrace section showing trace line cut back for joint. (Right) Special cast Unitrace flange for easy, efficient joining of new type Unitrace sections.

A L U M I N U M C O M P A N Y O F A M E R I C A

World's largest all-aluminum tank stands 26 feet high, has a diameter of 128 feet, holds 2⅓ million gallons of 83% ammonium nitrate solution.

standard and special storage tanks

Alcoa standard storage tanks, fabricated of 3003 alloy, are supplied in sizes ranging from 5,800 to 21,400 gallons. Both horizontal and vertical construction are available.

Made from stocked components, these standard tanks bring the user all the advantages of Alcoa Aluminum at lower cost, with faster delivery.

Storage tanks to meet many special requirements may be constructed of Alcoa sheet and plate. Information on design and fabrication will be furnished on request. Write for *Alcoa Standard Storage Tanks* Bulletin, AD387.

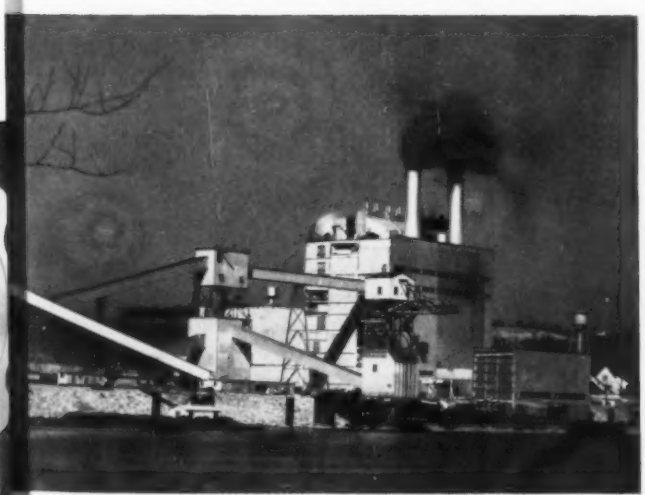
Alcoa Standard Tanks provide storage economies for a wide variety of chemicals.

shipping containers

Alcoa offers a wide variety of shipping containers conforming to ICC regulations. Ranging in size from 7½ to 110 gallons, they are used to ship such diverse products as beer and fuming nitric acid.

Alcoa aluminum containers are lighter in weight than containers of other suitable materials, are less expensive and give longer service.

roofing, siding, structurals and paint



Alcoa industrial building sheet is used for roofing and siding on plant buildings and to protect conveyors and other outdoor equipment. The aluminum surface requires practically no maintenance and lasts well even when exposed to corrosive atmospheres often encountered around processing areas. It is easily installed and helps to keep construction costs low.

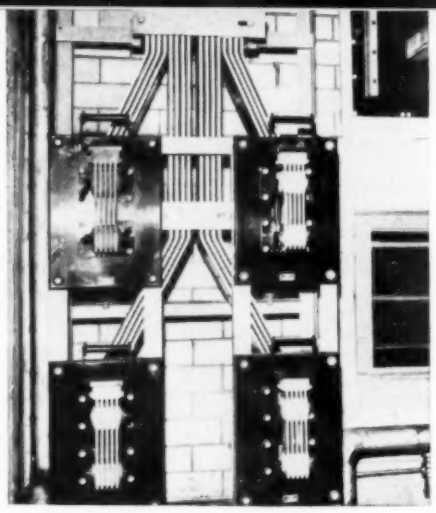
Alcoa also supplies structural shapes for use in construction where their corrosion resistance and consequent low maintenance cost are advantageous.

Paints pigmented with Alcoa Aluminum provide a continuous metallic sheet of pure aluminum for unmatched protective power.

Write for *Alcoa Industrial Building Products* booklet, AD285, *Alcoa Sandwich Walls* booklet, AD625, or *Painting With Aluminum* booklet, AD228.

Aluminum exterior surfaces for buildings and conveyors provide pleasing appearance with minimum maintenance.

ALUMINUM COMPANY OF AMERICA



bus bars

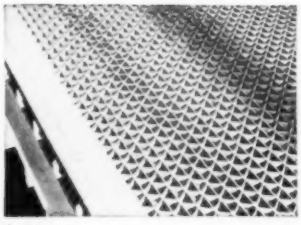
Lowest cost per unit current capacity and good corrosion resistance are key advantages for aluminum bus bars in process plants. Write for Alcoa Bus Conductor Handbook, AD661.

grating and tread plate

New grating-type Alcoa aluminum stair treads require no paint . . . are available in all standard sizes at a price competitive with galvanized steel and abrasive nosing. (Write for Bulletin AD679.)

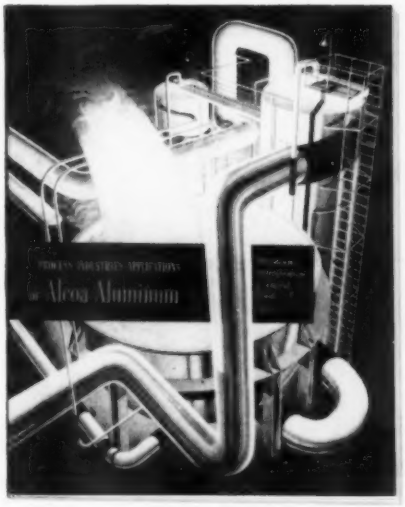
Aluminum grating is used widely for floors and walkways in and around processing plants because of its light weight, resistance to corrosion, low maintenance and nonsparking characteristics.

Alcoa supplies both a standard aluminum tread plate and Alcoa Abrasive Tread Plate. The latter has a self-renewing, bonded abrasive surface for extra nonskid protection. (Write for Bulletin AD596.)



this free book

. . . can be your dependable guide to solving corrosion problems in the process industries. Send for it now. Its 80 pages are filled with definitive data on the behavior of aluminum with specific materials . . . along with detailed design and specification information. Your copy will be sent promptly. Ask for Process Industries Book, AD460.



use Alcoa engineering assistance to solve your corrosion problems

In the course of many years' study of corrosion problems, Alcoa has acquired an immense fund of practical, nonconfidential information on corrosion characteristics of many materials and processes under various conditions. This information is available to you without obligation. Simply write Alcoa.

To insure receiving the most useful information, state your problem as specifically as possible. Alcoa's development engineers will then supply and help you evaluate the best available information.

Alcoa is also prepared to undertake cooperative testing programs in certain cases where existing data is insufficient. Contact your nearest Alcoa sales office for details.

Aluminum Company of America
893-J Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature (see above for book... nos.):

Name

Company Title

Address

City Zone State

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

THE ALCOA HO
TELEVISION'S FINEST
ALTERNATE SUNDAY

you can meet any lubrication specification if you

BLEND WITH ENJAY PARATONE®

(VISCOSITY-INDEX IMPROVERS)

Base stocks blended with Enjay Paratone can be compounded into lubricants combining cold-weather quick starting properties with high temperature, low consumption characteristics. These lubricants are *all-season* oils, featuring improved gas mileage. More and more refiners and blenders are relying exclusively on Paratone to produce the high "VI" required in these all-season oils.

Through years of intensive research and development work with automotive manufacturers, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Write, wire or phone the Enjay Company.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 WEST 51st ST., NEW YORK 19, N. Y.

Akron • Boston • Chicago • Detroit • Los Angeles • New Orleans • Tulsa

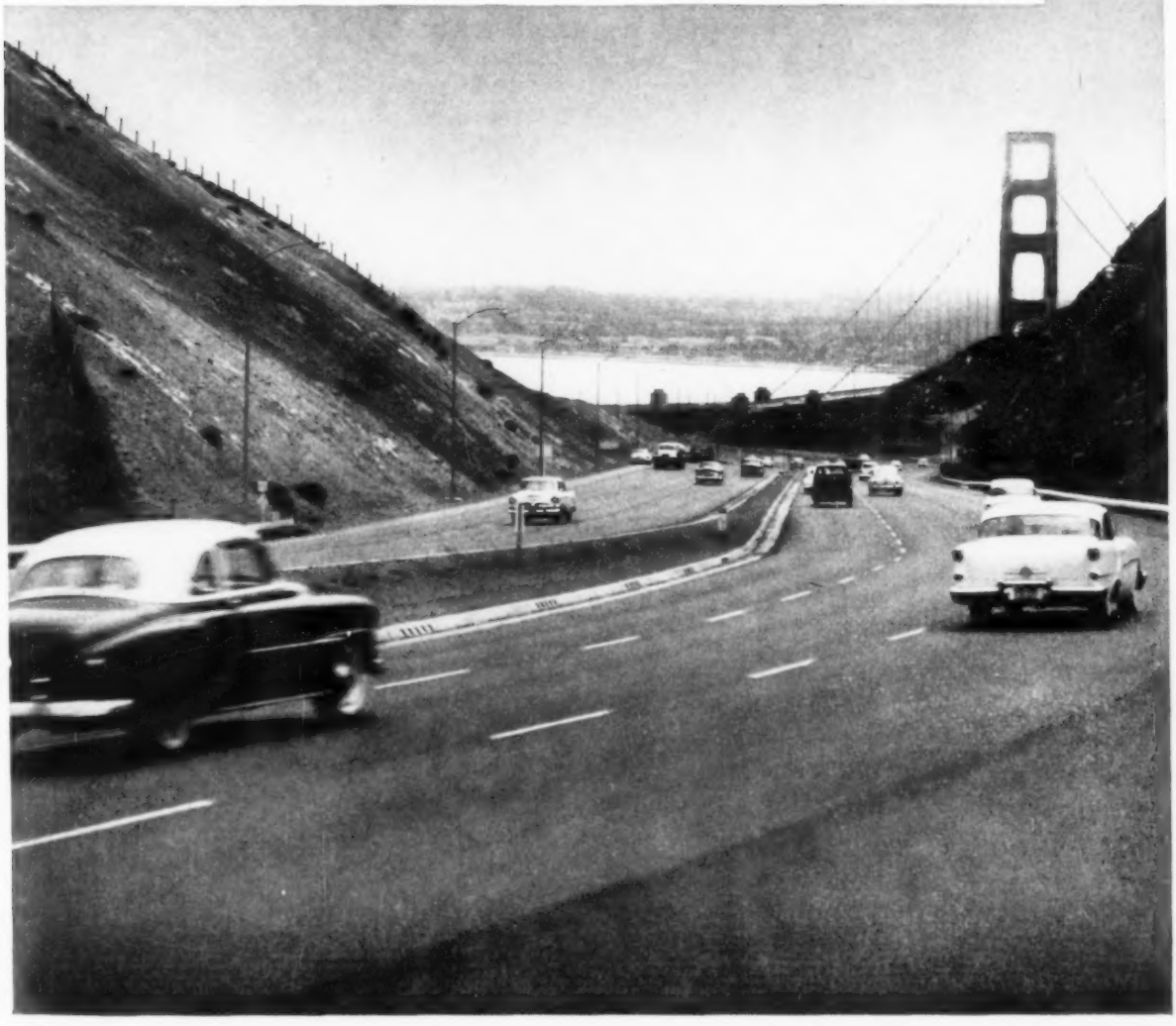


Photo courtesy of General Dynamics Corp.

When the *Skate*, U. S. Navy's newest atomic submarine, slid down the ways, she was equipped with Fulflo Filters.

When you need dependable micronic filtration, you, too, can rely on Fulflo Filters. They are engineered to your exact requirements — for all types of industrial fluids: oils; liquid chemicals; water; liquid fuels; lacquers, paints, thinners; compressed air, CO_2 and other gases. Standard models meet all normal operating conditions. Special filters can be engineered for full-flow filtration up to 2000 gpm or pressures as high as 5000 psi, at minimum pressure drop. Wide variety of filter elements and containers is available.

Call on Commercial for dependable micronic filtration. For technical literature or engineering assistance, address Department PP.

Micro-Fine Filtration for Low Cost Clarity

COMMERCIAL FILTERS CORPORATION

MELROSE 76, MASSACHUSETTS

Plants in Melrose, Massachusetts and Lebanon, Indiana

FULFLO FILTERS WITH GENUINE HONEYCOMB FILTER TUBES FOR CONTROLLED MICRONIC CLARITY • CFC MULTI-CARTRIDGE OIL FILTERS
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AUTOMATIC TUBULAR CONVEYORS • COOLANT CLARIFIERS

(To obtain more data on advertised products see page 222)

TRUFIN EASY TO USE WHEN RETUBING UNITS

An outstanding feature of Wolverine Trufin is the ease with which it can be substituted for plain tube during retubing operations. In manufacturing, Trufin's ends are left plain. Each end has a heavy wall section which is approximately two gauges heavier than the finned portion of the tube. Result: greater rolling or brazing flexibility at the header. The heavy ends also provide greater protection against inlet erosion.

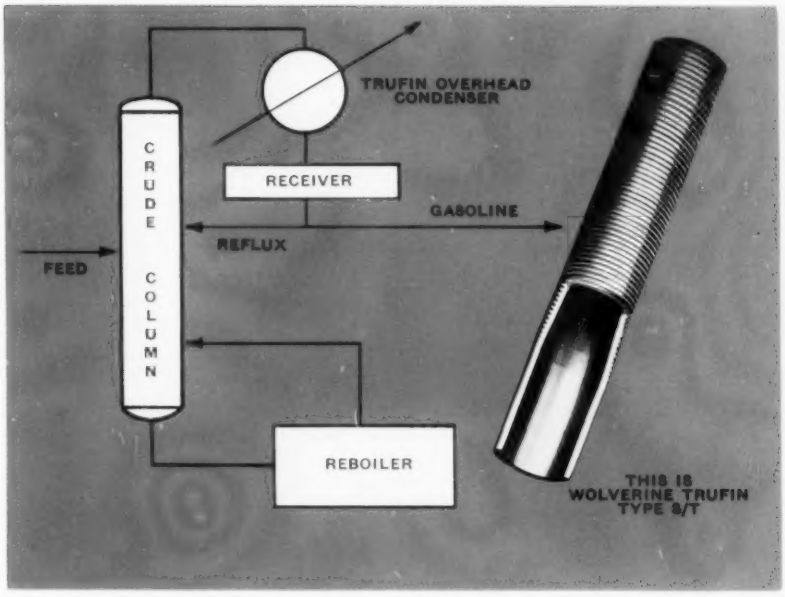
WOLVERINE TRUFIN CUTS DESIGN COSTS

Heat exchangers and condensers designed around Wolverine Trufin Type S-T, can in many cases, be fabricated more economically than with plain tube.

The use of Trufin—with its extended surface—for example, can reduce the number of lineal feet of tubing required to obtain a given heat duty. Fewer tubes mean, in turn, smaller shells, baffles and headers plus a substantial savings in labor. If the unit is to be used in overhead service there is also a saving in the amount of material normally required for superstructures.

NEW BOOK OFFERS COST COMPARISONS

Direct cost comparisons between the use of Wolverine Trufin and prime surface condenser tubing in heat transfer applications are given in Wolverine's new book "Comparative Heat Exchanger Costs." Just off the press, this new book contains valuable information—should be in the reference file of every processing engineer. Write today for your copy.



Retubing Does The Trick:

INTEGRALLY FINNED TUBE BOOSTS DEPROPANIZER CONDENSER OUTPUT

BY ERNEST DODD

Up until recently, in heat transfer work, a refinery engineer didn't have much choice when he wanted to increase heat duty. He could design a bigger unit—with increased surface area—or he could add another unit to those already on stream—providing of course, that he had sufficient room.

Well, it isn't that way anymore.

Nowadays—thanks to Wolverine Trufin® Type S-T—the refinery engineer can increase heat duty simply by retubing with integrally finned Trufin Type S-T. This is exactly what engineers at a west coast refinery did when they needed increased heat duty from an overhead depropanizer condenser on their fluid catalytic cracking unit.

After Trufin Type S-T—446 pieces, 16-feet long to be exact—had been substituted for the plain tube bundle, the initial boost in heat duty was 48%—a highly gratifying figure to all concerned. But that wasn't all.

During its days as a plain tube unit, this condenser had to be taken off stream for frequent cleanings. With Trufin Type S-T in the bundle, the unit has been in production for a full year without requiring cleaning—the first time this has ever happened.

Naturally there's a logical reason for this improved performance.

Wolverine Trufin Type S-T is an extended surface tube—gets its increased surface area from its integral fins which are actually squeezed from the tube wall. Because of this, Trufin has approximately 2½ times more surface area than does an equivalent piece of plain tube. Percentage wise this is an increase of 150%. It is this increased surface area that permits Trufin Type S-T to extract more BTU's per foot of tube.

Tests and authenticated case histories show that when Trufin fouls, the scale buildup follows the fin profile instead of preferring the valleys between the fins. Because Trufin does not present a flat surface, there is a tendency for the scale to fall away—which explains why Wolverine Trufin resists fouling and stays on stream for longer periods than prime surface tube.

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Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

FINNED TUBE BOOKS AVAILABLE—FREE!

Wolverine Tube, from its years of experience, has compiled and published literature of great interest to those engaged in heat transfer work. Among its catalogs and booklets are the COMPARATIVE HEAT EXCHANGER COSTS BOOK, TRUFIN CATALOG, CONDENSER TUBE CATALOG, PROCESS FLOW SHEET BOOK, WOLVERINE CORROSION CHART and the TRUFIN WATER HEATER BOOK. Any—or all—of these are yours—FREE. Why not write TODAY.

We've Been Asked:

WHEN TALKING OF WOLVERINE TRUFIN® WHAT DO YOU MEAN BY TYPE S/T?

BY ERNEST DODD

In addition to pioneering in the development of integrally-finned condenser tube, Wolverine Tube has also been responsible for coining the various designations used to describe different types of integrally finned tubing. Because of the increasing popularity of Wolverine Trufin®, we are often asked to explain just what these designations mean.

Actually, Wolverine Trufin is available in six different types—each designed for use in specific heat transfer applications. The most widely used is Trufin Type S/T named by Wolverine to identify its use in shell and tube condensers. Trufin Type S/T is a low finned tube with either 16 or 19 fins per inch (depending on alloy). The ratio of outside-to-inside surface area is approximately 3.75 to 1.

Wolverine also produces Trufin Type W/H, so named because it was designed primarily for use in water heaters. Trufin Type W/H is a high finned tube with 11 fins per inch. It has an outside-to-inside surface ratio of approximately 4.75 to 1.

To help the processing industry do a better hydrocarbon cooling job Wolverine developed an all-aluminum Trufin tube with integral fins on the outside and longitudinal fins on the inside. This tube is called Trufin Type I/L (internal longitudinal). It is available with 5, 7, 9, or 11 fins on the outside and has sufficient fins on the inside to approximately double the surface area. In addition to hydrocarbon cooling, Trufin Type I/L is also ideal for air cooling oil or in air-type refrigeration evaporators.

Trufin Type L/C is a high finned-lightweight aluminum tube mechanically bonded to an interior liner of any metal. Type L/C was designed to economically provide an extended surface tube with a liner core permitting adaptation to a variety of corrosion and/or pressure requirements. Type L/C, too, is ideal for air-cooled operations.

To facilitate insert type end connections by brazing, Wolverine developed an extended surface tubing with a controlled inside diameter—named it Trufin Type H/A (high area). Trufin Type H/A is a high finned tube with an outside-to-inside surface ratio of approximately 8:1. Air or gas flows outside the tube to be heated or cooled. The condensing or evaporating liquid is passed through the inside of the tube.

Finally there's Trufin Type H/R (high root)—similar to Type H/A. The root diameter is closely controlled and sufficient wall thickness allowed to permit the removal of fins for rolling into tube sheets. Type H/R is a high finned tube—has an outside-to-inside surface ratio of approximately 8:1.

And there, briefly, is a look into the background of integrally finned condenser tubing—a Wolverine development that is becoming more and more important with the passing of each day.

LOOK

FINS actually

E-X-T-R-U-D-E-D

from the tube wall!

The fact that its fins are part of the tube wall is the secret of the construction of Wolverine Trufin. It's the secret too, of the amazing performance records which Trufin-tubed heat exchange units are hanging up every day.

Because the fins and tube are all one piece, you are assured of constant efficiency. Fins are not impaired by vibration, temperature change or varying pressure. Trufin transfers *more* BTU's per foot of tube—permits you to design more compact units—steps up the capacity of existing ones.

Trufin is fabricated as easily as plain tube, too. In fact, standard tools and techniques are used. Fabricated Trufin units are often stronger than units using plain tube because fins provide additional support at bends. Remember: You can *depend* on Trufin for *dependable* heat transfer!

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Petroleum Processing

VOLUME 12

JANUARY – SEPTEMBER 1957

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330 WEST 42nd STREET
NEW YORK 36, NEW YORK

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TROUBLE FREE... You can't buy a more trouble-free, leak-proof valve than Rockwell-Nordstrom; that has been proven over the last 40 years. The basic reasons: a durable, *pressurized lubricant* seal holds the lightest gases or heaviest slurries bottle tight. And, *lubricant protection* eliminates metal-to-metal wear —prevents valve failure, keeps maintenance costs lower than any other valve.

Rockwell-Nordstrom, the world's most complete line of lubricated plug valves, will give you better flow control at lower cost everywhere you use them. And they cost no more to buy, often less, than ordinary valves. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed For Positive Shut-Off

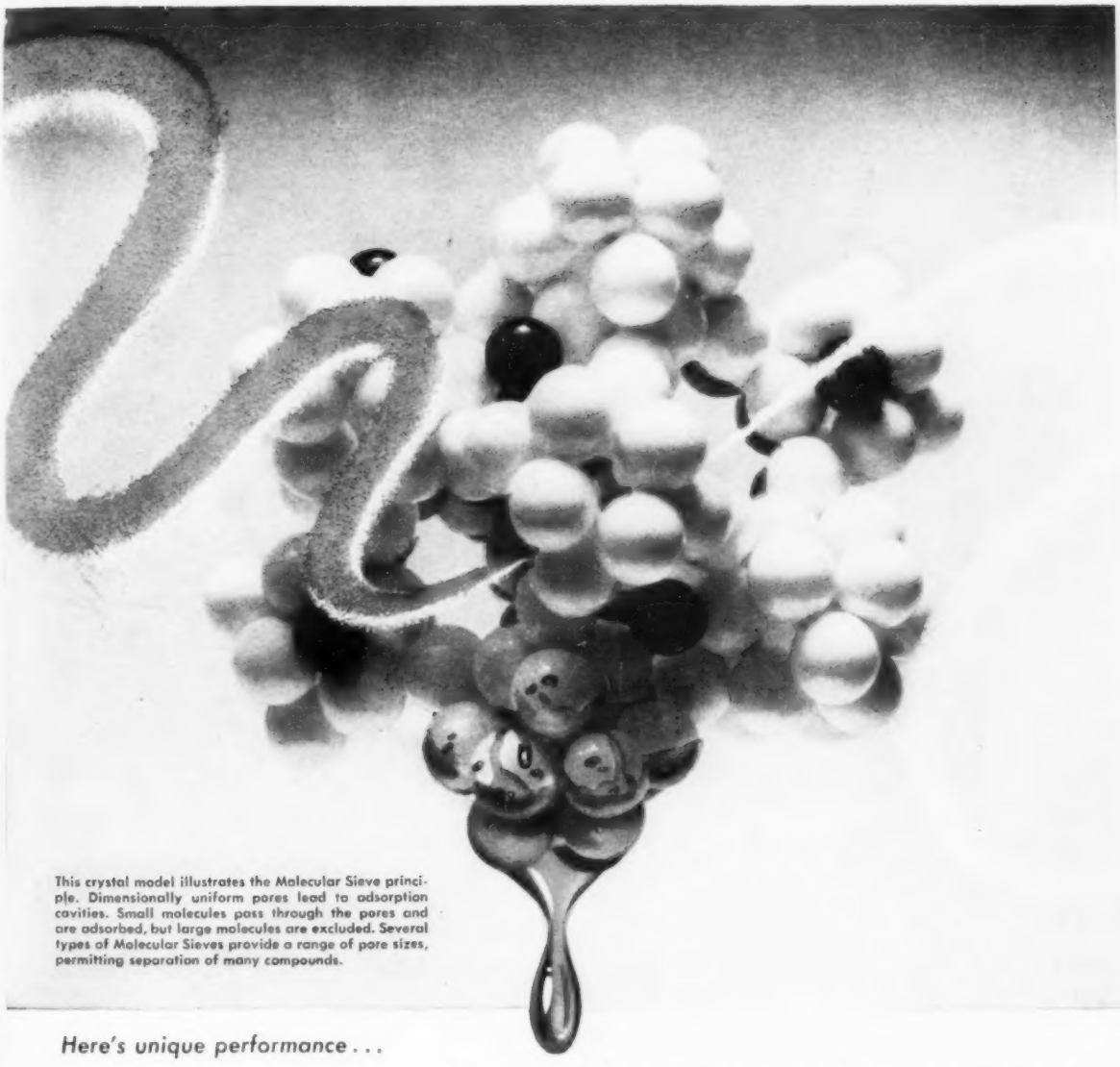
RUGGED Rockwell-Nordstrom valves *stay* trouble-free on pump and compressor lines. Why? Their firmly seated, lubricated plug prevents seat failures that are common to ordinary valves on high pressure or pulsating flow. And even on hard to handle services, shut-off is always positive because a tough film of lubricant forms an instantly replaceable, double seal against leakage.

Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves and lubricated plug valve accessories. They cost no more to buy, often less, than ordinary valves and they'll save money, give better performance everywhere you use them. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Available at leading suppliers . . . everywhere.

ROCKWELL-
Nordstrom
VALVES

Lubricant Sealed For Positive Shut-Off



This crystal model illustrates the Molecular Sieve principle. Dimensionally uniform pores lead to adsorption cavities. Small molecules pass through the pores and are adsorbed, but large molecules are excluded. Several types of Molecular Sieves provide a range of pore sizes, permitting separation of many compounds.

Here's unique performance . . .

Molecular Sieves for Purification and Recovery!

. . . selective removal of contaminants, at temperatures up to 300°F!

. . . selective recovery of valuable stock without regard to relative boiling points!

Molecular Sieves, a new class of adsorbents developed by Linde Company, offer selective separation of gas or liquid mixtures in three ways . . . difference in molecule size . . . or polarity . . . or carbon bond saturation. And, co-adsorption can be utilized to remove several impurities simultaneously.

Typical uses? Removal of catalyst poisons from olefins . . . or extraction of olefins from refinery streams and top gases . . . or simultaneous dehydration and sweetening of natural gas . . . and many, many others.

LINDE Molecular Sieves offer new performance advantages . . . for many production uses. You may be able to lower costs, simplify processes, improve a product with this unique adsorbent. Find out more by writing for data describing Molecular Sieve properties and performance characteristics, Dept. PE-9, Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y.

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation

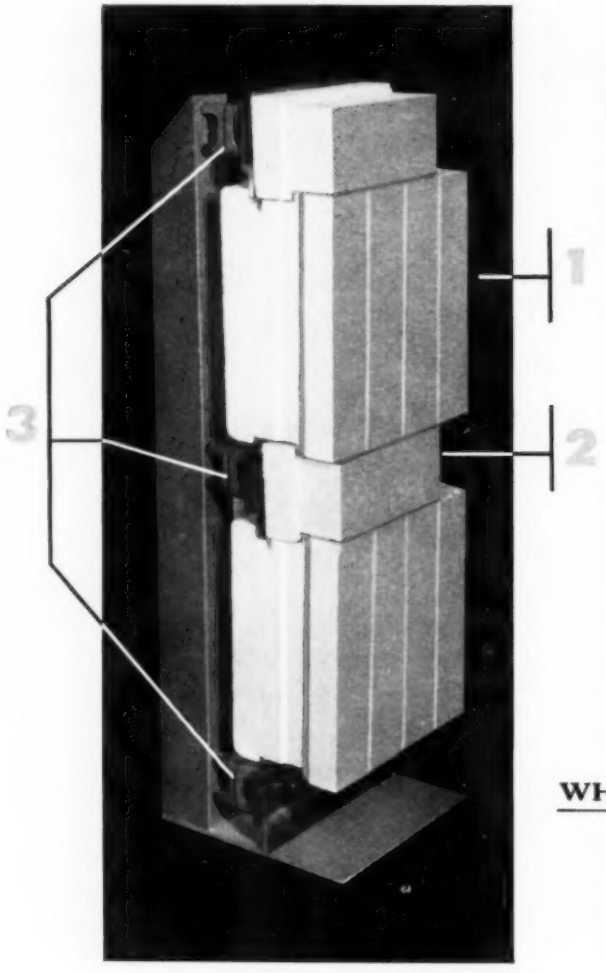
Linde TRADE MARK MOLECULAR SIEVES

UNION CARBIDE

IDEA FILE:

Big problem these days is saving money on capital goods equipment —without sacrificing performance. A combination of ideas from Bigelow-Liptak's engineering department involves the use of two established wall designs • • •

LIKE THIS:



IDEA and SAVING NO. 1

Use a seven-inch tile for maximum refractory thickness.

IDEA and SAVING NO. 2

Employ a five-inch filler tile. (Place insulation or fire clay in front of supporting casting.)

IDEA and SAVING NO. 3

Increase space between horizontal castings and eliminate a number of castings.

and – for FLEXIBILITY

Air cool the wall—or use economical thicknesses of block and plastic insulation depending upon temperature requirements.

WHERE THIS DESIGN IS USED:

For refinery oil heaters, municipal incinerators or power plants where economy is a must, but where performance has got to be good. Write for details.

BIGELOW-LIPTAK
CORPORATION
AND BIGELOW-LIPTAK EXPORT CORPORATION
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UNIT-SUSPENDED WALLS AND ARCHES

Now!

Davison
antioxidants

Davison, long the leading catalyst supplier, now offers two antioxidants to the refining industry . . . Dav-Ad 101 and Dav-Ad 102.

You'll find these antioxidants offer more advantages than other types for use in a long list of products: motor and aviation gasoline; turbine, transformer and lubricating oils; jet fuels; synthetic lubricants; various plastics; rubber; asphalt tile; waxes; industrial fats and oils.

Dav-Ad 101 is available in 100-pound fiber drums . . . Dav-Ad 102 in 55-gallon steel drums containing 400 pounds net, or in tank car lots. Stocks are located at Baltimore, Md., Lake Charles, La. and Cincinnati, Ohio for your convenience.

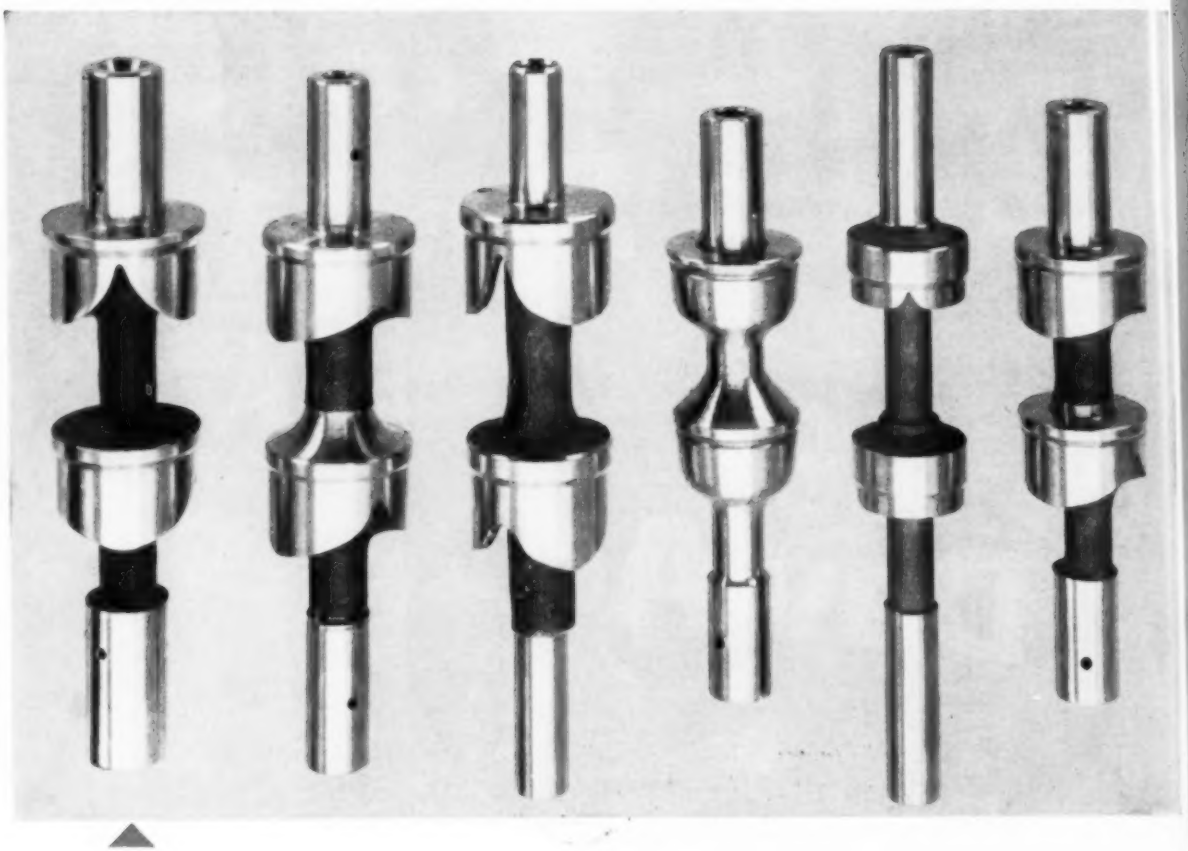
Write today for samples, specifications and prices.

Progress Through Chemistry

DAVISON CHEMICAL COMPANY
Division of W. R. Grace & Co.
Baltimore 3, Maryland

SALES OFFICES: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.; San Francisco, Calif.; Tulsa, Okla.
In Canada: Davison Chemical Company Ltd., Toronto.

 (To obtain more data on advertised products see page 222)



Inner secrets of inner valves

FACTS EVERY CONTROL VALVE USER SHOULD KNOW

This is a rare photograph . . . presented in a completely unretouched form. It shows the inner valve of leading makes of diaphragm control valves. The inner valve determines the control result.

The most amazing fact is the size . . . all are *listed* as two inch valves. All are high lift. But compare them.

Note the KIELEY & MUELLER inner valve at the far left. It equals the others on every point of consideration; exceeds on many. Look at the diameter across the skirt . . . that's one reason for the remarkable C_v of K&M valves. Look at skirt length; the solid, not fabricated, design. Measure the rugged guide posts and the large column. Examine the machining and the super-finishing.

It's no wonder . . . K&M is *the valve that likes to be compared*. It's a better valve and a better value by every measure of comparison.

FOR THE COMPLETE FACTS . . .
write for the K&M Valve Engineering Data Catalog, Bulletin CV53.

K&M

diaphragm control valves

KIELEY & MUELLER, INCORPORATED

Our 78th Year

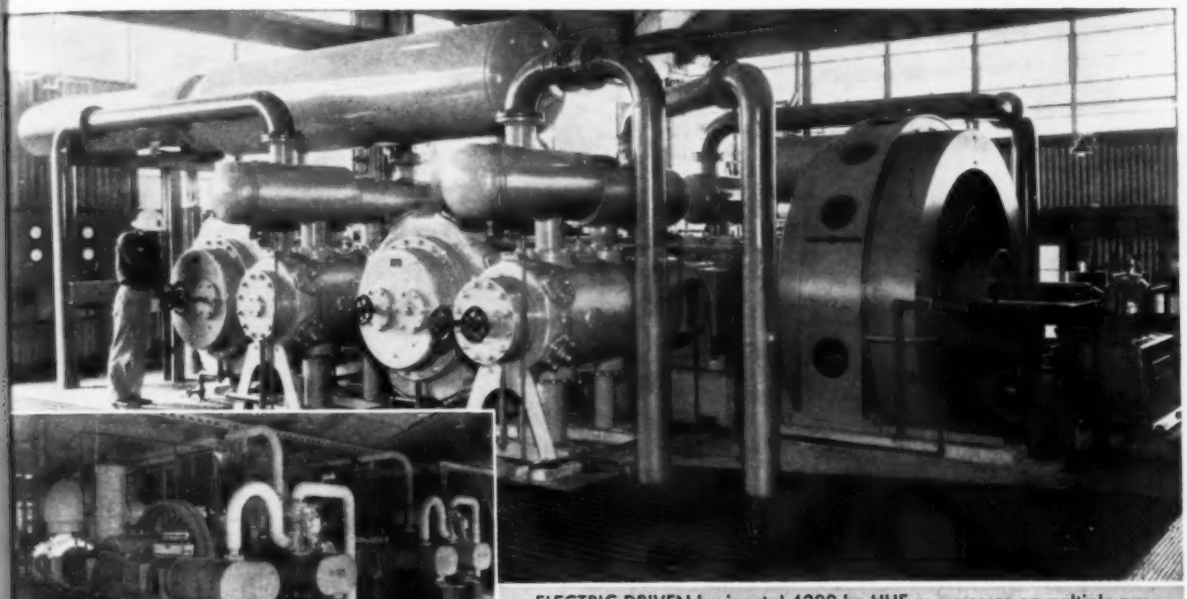
Oldest Pressure and Level Control Valve Manufacturer

64 Genung Street, Middletown, New York

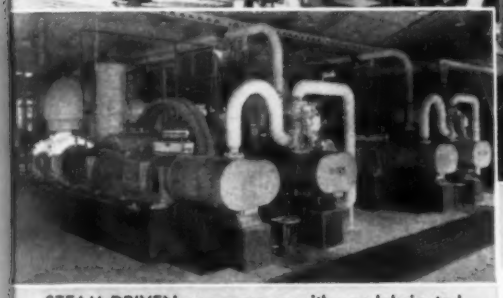
(To obtain more data on advertised products see page 222)

what assures a

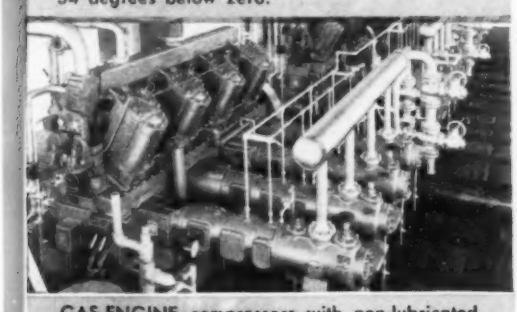
GOOD COMPRESSOR for PROCESS WORK?



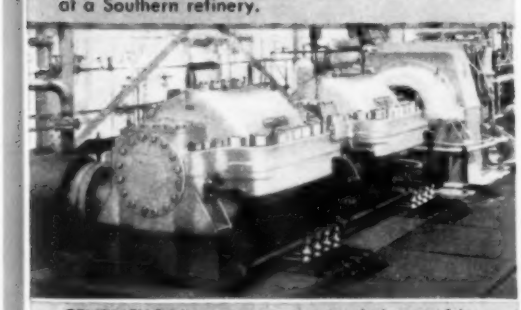
ELECTRIC-DRIVEN horizontal 4000-hp HHE compressor on multiple-gas service, compressing air to 645 psi, nitrogen to 330 psi and natural gas to 440 psi simultaneously in an ammonia plant.



STEAM-DRIVEN compressors with non-lubricated cylinders handling hydrogen chloride gas at 54 degrees below zero.



GAS-ENGINE compressors with non-lubricated compressor cylinders on hydrogen recycling duty at a Southern refinery.



CENTRIFUGAL compressors on ethylene refrigeration; these are tandem units driven by steam turbine.

In process jobs, any interruption of the cycle often means large loss of production, expensive repairs, and introduction of hazardous conditions. In manufacturing compressors for these jobs, there is one ingredient most vital.

That ingredient is knowledge. The compressor manufacturer must know how to predict conditions in the process which might force a shutdown, and must know how to meet those conditions with a compressor which will minimize the possibility of a shutdown.

Such knowledge is obtained only through years of actual experience in designing, building and applying compressors for all sorts of processes, for handling all kinds of gases, and for any range of pressures.

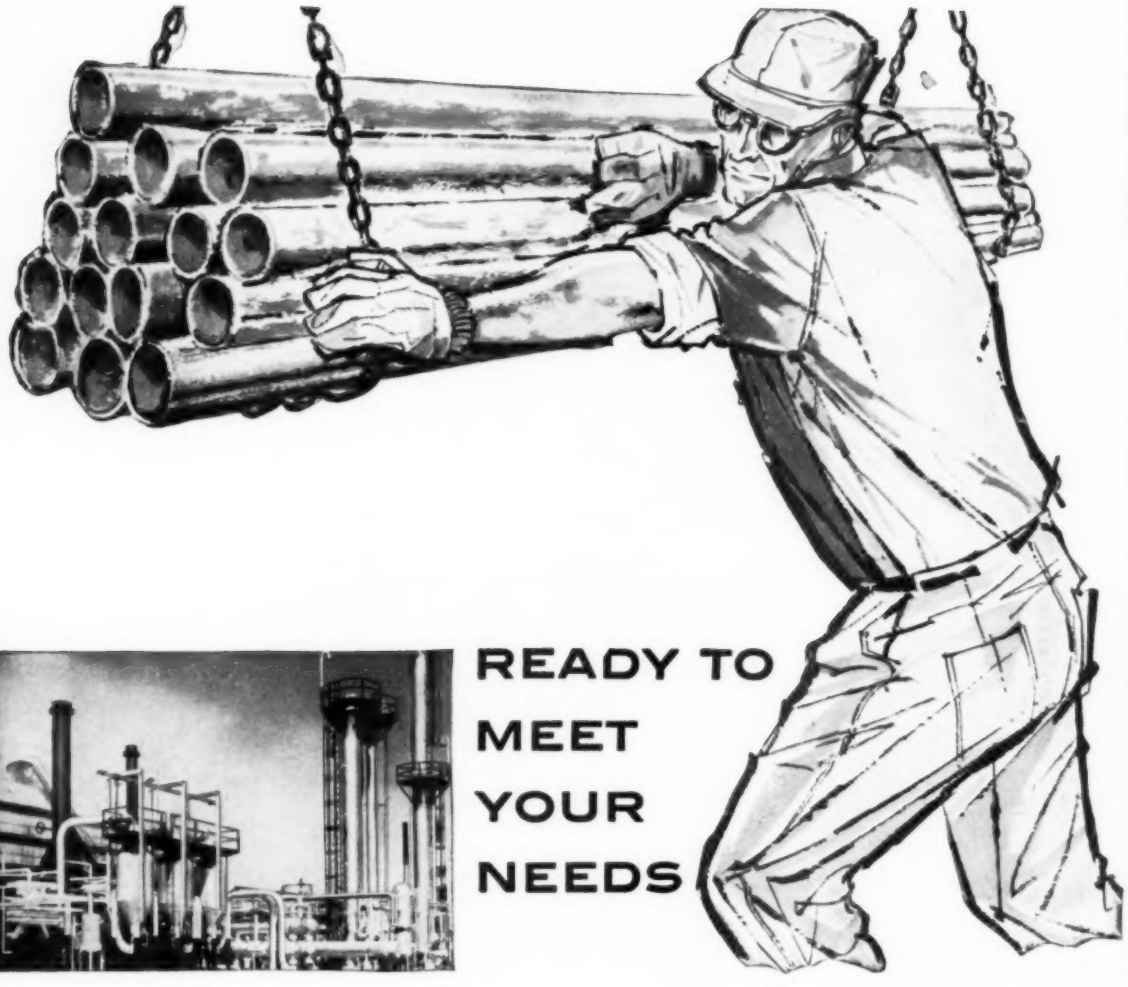
Ingersoll-Rand has more of that kind of experience than any other compressor builder. For information on process compressors for pressures up to 35,000 psi, contact your I-R representative or write direct. Ask for your copy of Form 3132A.

Ingersoll-Rand

I-598

11 Broadway, New York 4, N.Y.

COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS



READY TO MEET YOUR NEEDS

THERMALLOY* CENTRIFUGALLY CAST

REFORMER FURNACE TUBES

Recent expansion of Electro-Alloys' centrifugal casting facilities means we can better meet your needs for Reformer Tube Assemblies. Even more important, you are assured of assemblies that are stronger, free of leaks . . . that last longer without warping or cracking.

Here's why!

1. Thermalloy tube sections are centrifugally cast to your specific diameters . . . to insure greater density, finer grain structure and uniform thickness.
2. Technicians control the soundness of tube sections, by X-raying and pressure testing.
3. Skilled Electro-Alloys metallurgists and engineers help you select the grade of Thermalloy heat-resistant alloy best suited to your specific application.

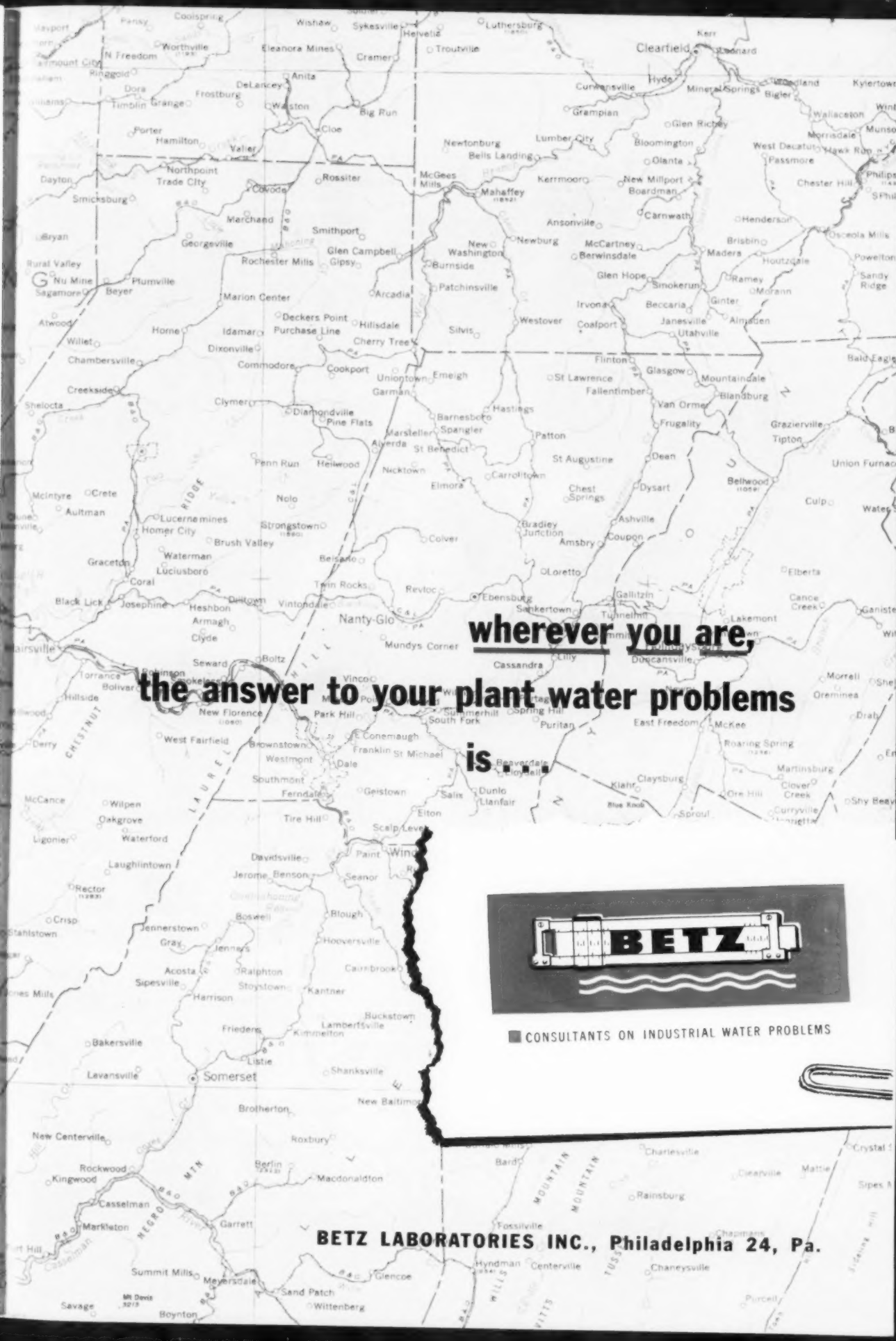
For further information on Thermalloy Reformer Furnace Tube Assemblies, call your nearby Electro-Alloys representative. Or write for Bulletin T-283. Electro-Alloys Division, 8079 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

THERMALLOY TUBE SUPPORTS . . .
wall tube brackets and intermediate tube supports are also available. Or let us quote on your specifications.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio


wherever you are,
the answer to your plant water problems
is . . .
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

the most ECONOMICAL maintenance is PREVENTIVE maintenance

TWO OF THE MOST EFFECTIVE PREVENTIVE MAINTENANCE MEASURES ARE:

1 *98% to 100% SALT REMOVAL with Tretolite Chemical Desalting*

Tretolite Desalting prevents salts, solids, trace metals and other impurities from entering the refinery stream. It prevents salt plugging and fouling in condensers, exchangers and towers, reducing clean-outs and tube rattling to minimum. Tretolite Desalting is an automatic, all-chemical process that consistently delivers salt removals in the 98% to 100% range.

2 *EFFICIENT CORROSION PREVENTION with Kontol Corrosion Inhibitors*

Kontol Corrosion Inhibitors prevent internal corrosion and hydrogen blistering and help to eliminate scale and fouling difficulties. Kontols are readily adsorbed from hydrocarbon solutions at metal surfaces to form a tough impervious film. In addition to their inhibiting properties, the Kontols are powerful detergents which clean and de-foul refinery equipment.

Ask the man in the red car

The Tretolite Service Engineer is always on call to assist you in your maintenance and processing problems.

AR-57-1

TRETOLITE COMPANY

A Division of Petrolite Corporation

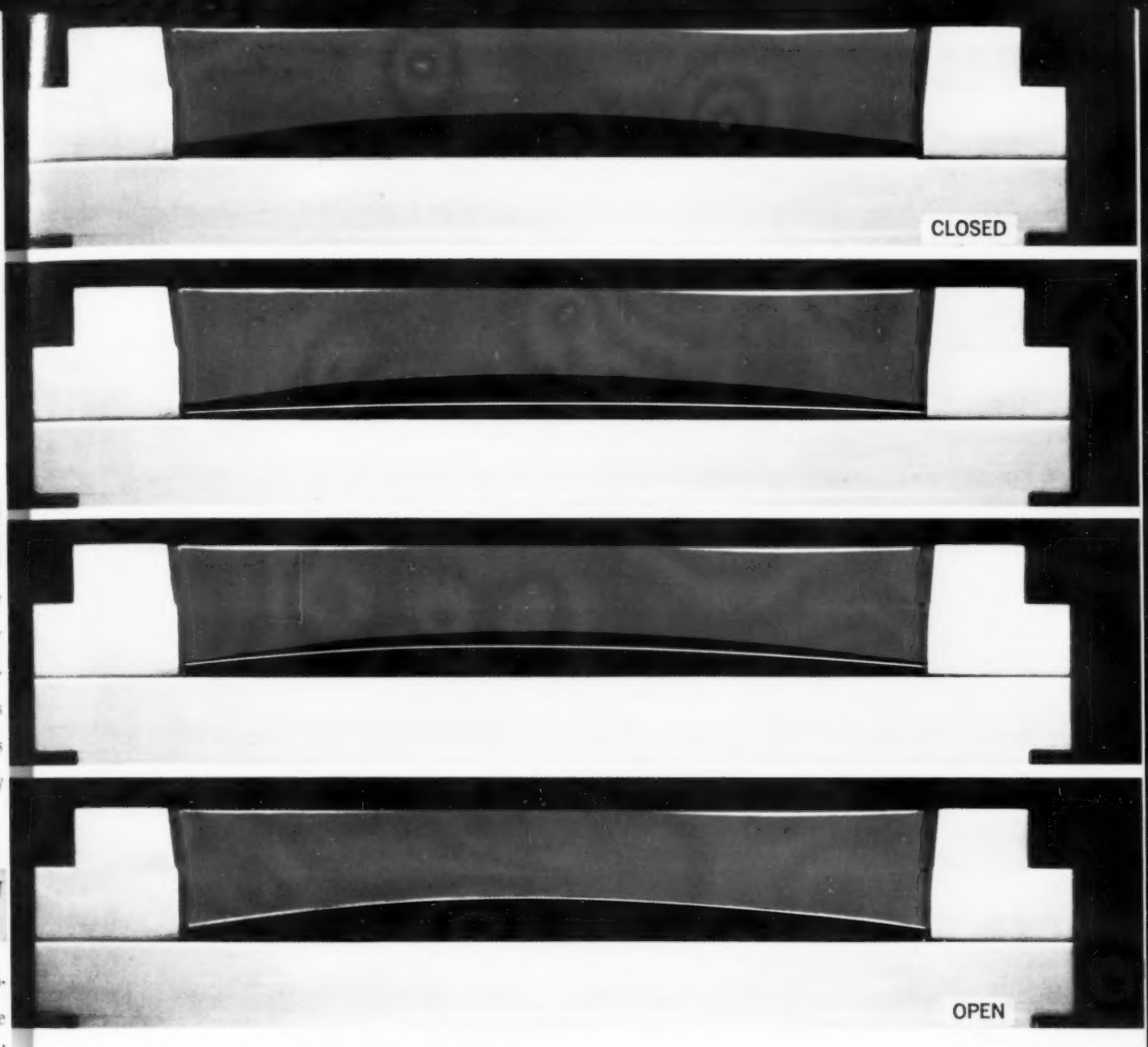
369 MARSHALL AVENUE, ST. LOUIS 19, MISSOURI

5515 TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA

Chemicals and Services for the Petroleum Industry

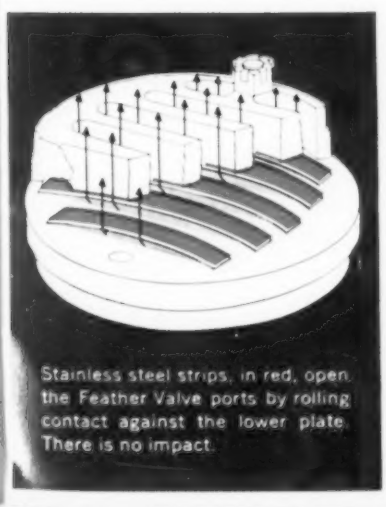
DESALTING • DEMULSIFYING • CORROSION INHIBITING • SCALE PREVENTING

FUEL OIL ADDITIVES • WATER DE-OILING • METAL DEACTIVATORS



Key to Compressor Reliability . . .

WORLD'S SIMPLEST COMPRESSOR VALVE!



Stainless steel strips, in red, open the Feather Valve ports by rolling contact against the lower plate. There is no impact.

The Feather Valve® is the only compressor valve with no buffer plates or cushioning accessories. The strip is the only moving part and the valve itself is all but indestructible. The fastest-acting on the market, Feather Valves are standard equipment on all Worthington compressors.

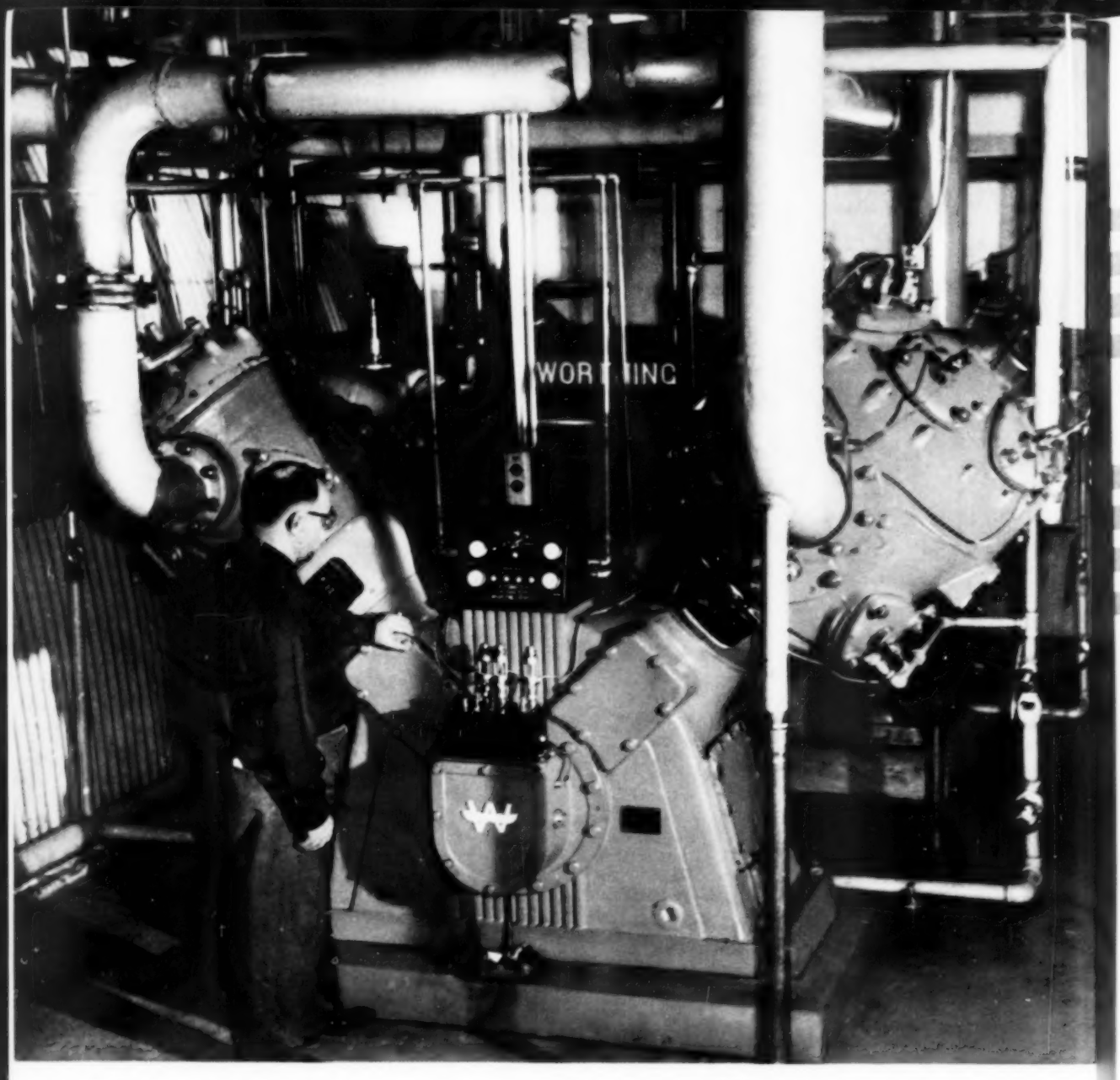
Their extremely fast action means you get virtually no slip or backflow. As a result Worthington compressors give you minimum valve loss and use minimum power.

No Impact. Combined with fast action is Worthington's exclusive "no impact" operation which assures long life and negligible maintenance. The flexible strips open and close with a gentle rolling contact.

For a first hand story of a Feather Valve's ruggedness, see the next page.

WORTHINGTON

®Reg. U. S. Pat. Off.



Feather Valve compressors at Twin Coach plant . . .

IMPROVE AIR SUPPLY, CUT MAINTENANCE

"This compressor installation cut maintenance costs and improved reliability," reports John Anthony, Twin Coach Company, Aircraft Division plant in Buffalo, New York. "We centralized our compressed air supply with installation of three heavy duty, water-cooled, 2-stage 100 psi Worthington Feather Valve compressors."

Constant-pressure, reliable air supply is the basic Twin Coach manufacturing power service. Regular scheduled preventive maintenance inspections (only four times per year) show that these compressors are giving entirely satisfactory performance.

Valves are your key to compressor reliability. Feather Valves, interchangeable between compressor suction and inlet, are the surest acting, tightest, most flexible and fastest made. They are most reliable because they are simplest.

For information regarding your compressed air needs, contact Worthington Corporation, Section K-72, Harrison, New Jersey, stating requirements—or contact your local Worthington representative located in every major city.

WORTHINGTON

See preceding page

THE NAME TO WATCH IN

HEAT TRANSFER EQUIPMENT

YUBA HEAT TRANSFER DIVISION

formerly HEAT EXCHANGER DIVISION OF THE LUMMUS COMPANY

Important to every user of heat transfer equipment is the acquisition of the Heat Exchanger Division of The Lummus Company by Yuba Consolidated Industries, Inc. The management, sales and engineering personnel, as well as the designs, patents, and manufacturing facilities of the former Lummus operation at Honesdale, Pennsylvania, are now part of the YUBA nation-wide organization. YUBA is proud of the opportunity to identify its name with the long established recognition enjoyed by Lummus in the power industries, as well as in the chemical and petroleum processing fields. The continuing pioneering development for which Lummus has been known, and its existing commitments and obligations, will be carried forward in every phase under the YUBA name. For your current and future requirements consult YUBA first.

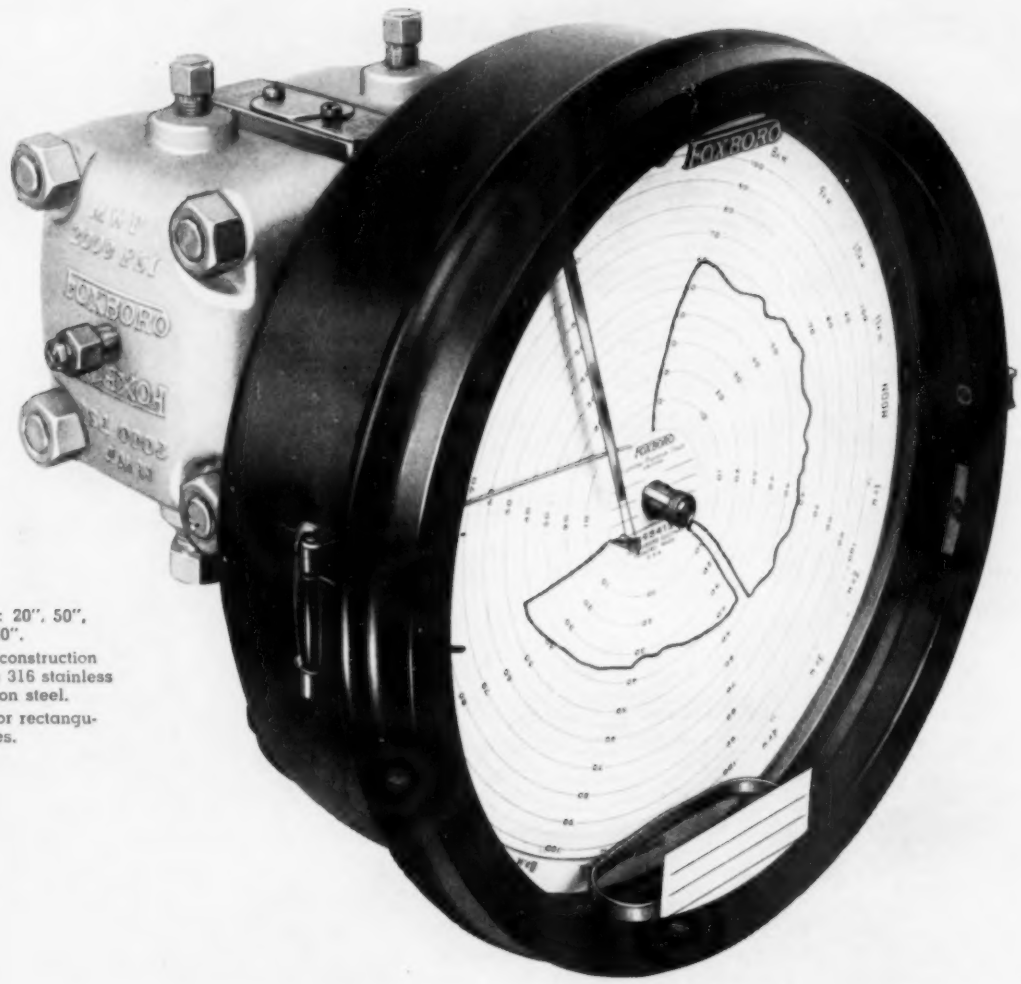
YUBA HEAT TRANSFER DIVISION

General Sales Offices and Plant — Honesdale, Pennsylvania
Eastern Division Sales Office — 385 Madison Ave., New York, N.Y.
Other Yuba Consolidated Industries, Inc. Plants: Buffalo, N.Y. • Richmond, Calif. • Benicia, Calif.

YUBA
CONSOLIDATED INDUSTRIES, INC.

NATION-WIDE SALES REPRESENTATION IN PRINCIPAL CITIES

NOW... a "Dry" Flow Meter with

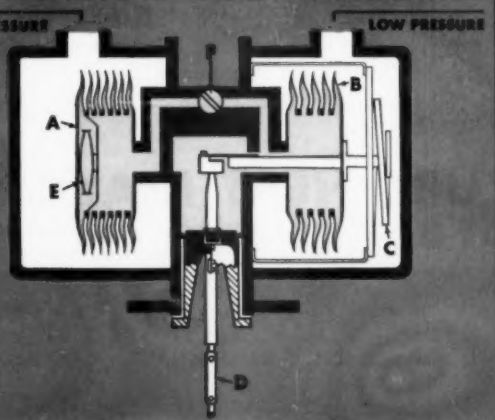


- Ranges: 20", 50", 100", 200".
- Forged construction in Type 316 stainless or carbon steel.
- Round or rectangular cases.

...the new Foxboro Type 37 Diaphragm Meter

How It Works

In schematic drawing at right, areas shown in color represent a stable, non-freezing liquid. Any pressure increase in the high pressure chamber compresses Diaphragm Unit A, displacing its liquid and expanding Diaphragm Unit B until force of Range Spring C equals the difference between the forces on Diaphragm Units A and B. Linear motion of Diaphragm Unit B moves inner end of Drive Bar D — outer end moves correspondingly through the bellows-sealed flexure bar, driving pen arm. Built-in Temperature Compensator (E) proportionately adjusts diaphragm capacity as ambient temperature variations affect volume of filling fluid. External damping adjustment is shown at F.



• complete overrange protection!

• sustained high accuracy!

Now you can have mercuryless flow measurement for a wide range of differential pressures — at static pressures up to 2000 psi — with greater safety and dependability than ever before!

The new Foxboro Type 37 Diaphragm Meter not only combines unmatched ruggedness and precision in a dry meter — it's by far the easiest to adjust and maintain. And it does away with zero drift problems, once and for all!

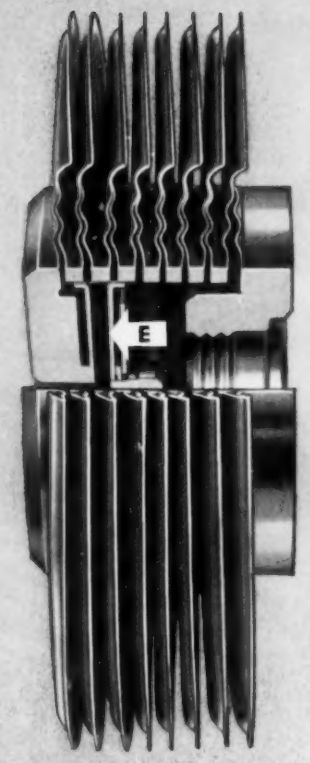
Expansible, Type 316 S.S. diaphragm elements respond to changes in pressure with unmatched sensitivity, yet are completely immune to overrange up to full static pressure! A unique packless drive bar precisely transmits linear motion to the pen arm. Range-changing is easy, due to new twin-spiral spring design. Wide range damping is externally adjustable under pressure. And the Type 37 is self-compensating for temperature changes in all differential ranges.

Get full details on this high utility, completely dependable dry flow meter. Arrange for a demonstration with your nearby Foxboro Field Engineer, or write The Foxboro Company, 919 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO

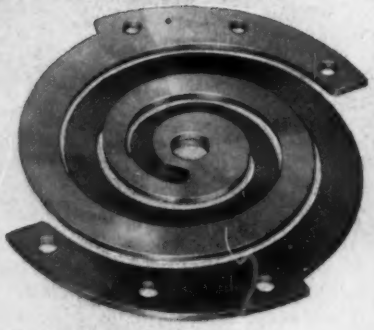
REG. U.S. PAT. OFF.

FIRST IN FLOW METERING



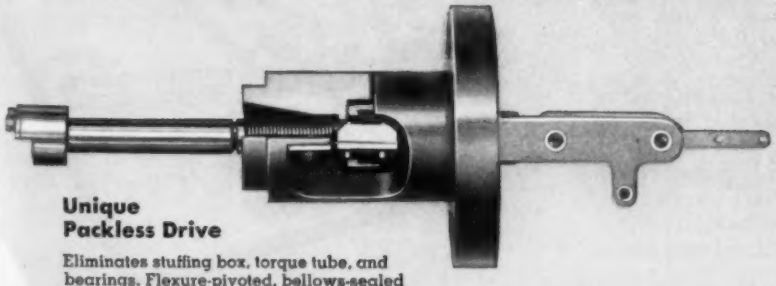
Exclusive Diaphragm Elements

Type 316 S.S. diaphragm units in both high and low pressure chambers provide greatest linearity and freedom from hysteresis; nesting design and integral spacer rings provide safe, positive, overrange protection. Temperature compensation (E) is built into diaphragm assembly . . . *never* requires change or adjustment.



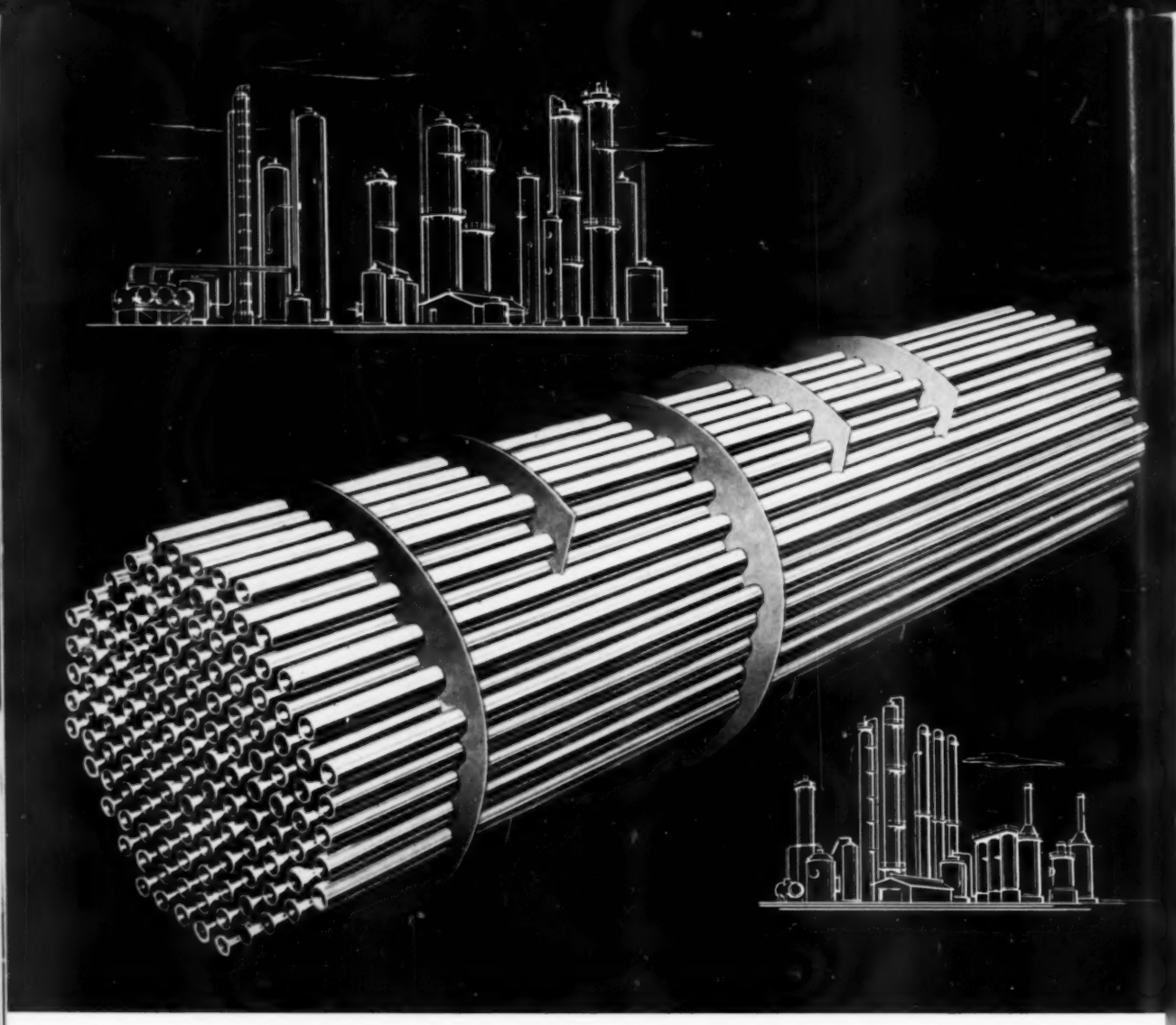
Exclusive Range Springs

Heavy gauge Ni-Span C alloy, twin-spiral springs provide high sensitivity with lasting accuracy. Readily accessible . . . range changes are easily made, in minutes!



Unique Packless Drive

Eliminates stuffing box, torque tube, and bearings. Flexure-pivoted, bellows-sealed drive bar transmits diaphragm's linear motion to the pen arm with unequalled sensitivity *and undiminished* power. Seal for flexure pivot is a tough, flexible bellows.



YOU SAVE WHEN YOU SPECIFY

B&W ERW Tubing For Heat Transfer Equipment

When you specify B&W Electric-Resistance-Welded Carbon Steel Tubing in your heat transfer equipment, you not only have lower original cost—you are assured of savings where they count—in operating costs. Its uniform wall thickness provides high heat transfer efficiency. And dimensional accuracy from tube to tube assures easier fitting into tube sheets with less time required for rolling-in operations.

Used in oil preheaters and heat exchangers at major refineries, B&W ERW Tubing is made to ASTM and ASME specifications. It must pass rigid inspection and testing standards in manufacture. Its value has been proved in such heat transfer applications as boilers, condensers, preheaters, economizers, evaporators, and refrigeration equipment.

A call to Mr. Tubes, your nearby B&W Tube representative, will bring you economical recommendations plus quick deliveries. Write for Bulletin 412. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-7008-FP2

Seamless and welded tubular products, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels.

over 1,000,000 tons/yr of petrochemical know-how

- ammonia
- butadiene
- butyl rubber
- ethylene
- dodecyl benzene
- hydrogen
- methanol
- urea

MORE than twenty FW process installations totalling more than a million tons capacity per year are now in operation or under construction.

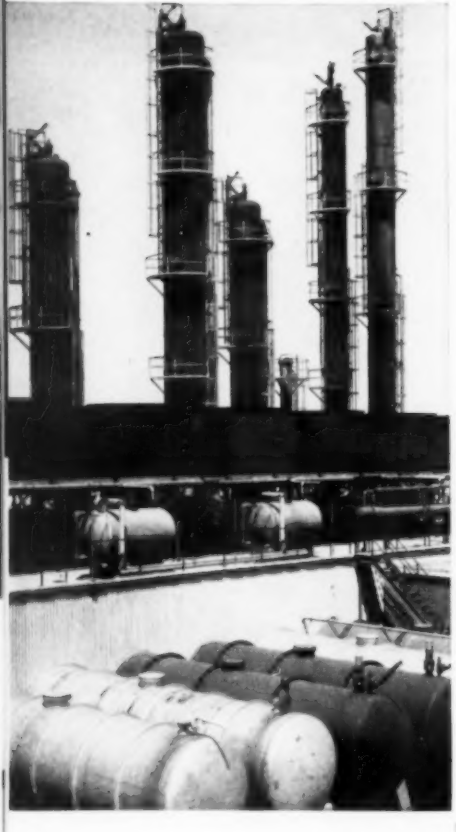
This specialized know-how — encompassing design, engineering, fabrication and erection all over the world — gives Foster Wheeler a firm foundation for serving the requirements of all producers planning process facilities in the expanding petrochemical industry.

Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

Almost everything you see here is **STAINLESS STEEL** ... Celanese Corporation plant uses **1,300 tons** of it



CELANESE CORPORATION'S Pampa, Texas, plant was built in 1951. It produces acetic acid, acetic anhydride and related compounds by the air oxidation of liquefied butane. Briefly, the butane is oxidized in the reaction unit, transformed into acetic acid and other compounds which are fractionated in the purification unit, then further processed.

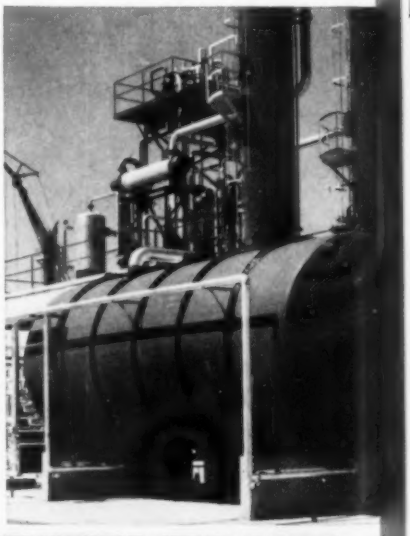
Throughout the entire process from the reaction units to the finishing operations, *Stainless Steel is used almost exclusively for process equipment and piping in contact with the product.*

Some 1,300 tons of Stainless were used in the original plant. Since then, expansion has added hundreds of additional tons. All the equipment is *solid* Stainless Steel, mostly Types 316 and 317 welded with Type 317 rod.

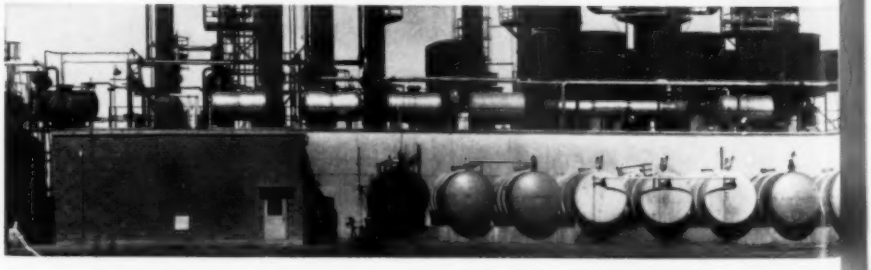
Management feels that Stainless Steel plays an important part in the smooth, efficient operation of this plant. Failures are few and predictable, in contrast to other materials that may fail disastrously and without warning.

Because of its reliability, Stainless was installed here *at the beginning*, and it has paid its own way, over and over again.

United States Steel Corporation, Pittsburgh
American Steel & Wire Division, Cleveland
Columbia-Geneva Steel Division, San Francisco
National Tube Division, Pittsburgh
Tennessee Coal & Iron Division, Fairfield, Ala.
United States Steel Supply Division, Warehouse Distributors
United States Steel Export Company, New York



SHEETS • STRIP • PLATES • BARS
BILLETS • PIPE • TUBES
WIRE • SPECIAL SECTIONS



USS STAINLESS STEEL

UNITED STATES STEEL

Here's Why Oil Men Specify
EC&M HIGH VOLTAGE STARTERS

2200-4800 Volts
Totally Oil-Immersed

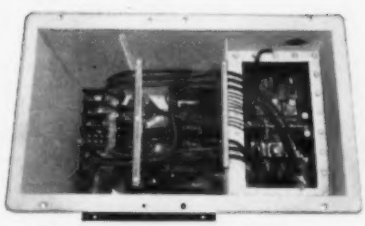
EC&M Type ZHS Starters at Southwestern pipe line trunk station

Designed for Easier Installation, Inspection and Maintenance

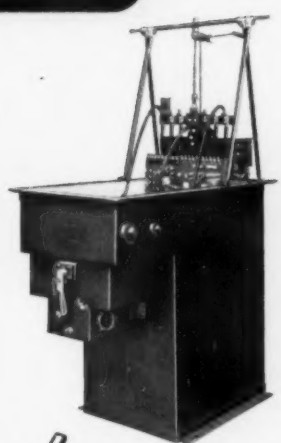
Specifically designed for Class I, Group D, Division 2, semi-hazardous locations . . . NEMA 3R (raintight enclosure). 50,000 KVA interrupting capacity.

***Fast* installation** because starters are shipped with all internal wiring complete. All leads are of anti-syphon construction.

Easy inspection • Contactor and overload relay panel may be raised, as one unit, above oil level. No disconnecting of bolts or leads. *(See lifting mechanism at extreme right.)* Safer, too . . . note view windows on each side of load-break disconnect switch.



View from above shows complete internal wiring . . . anti-syphon leads. These "ready-to-use" starters are complete with control transformer for 220 volt push button operation.



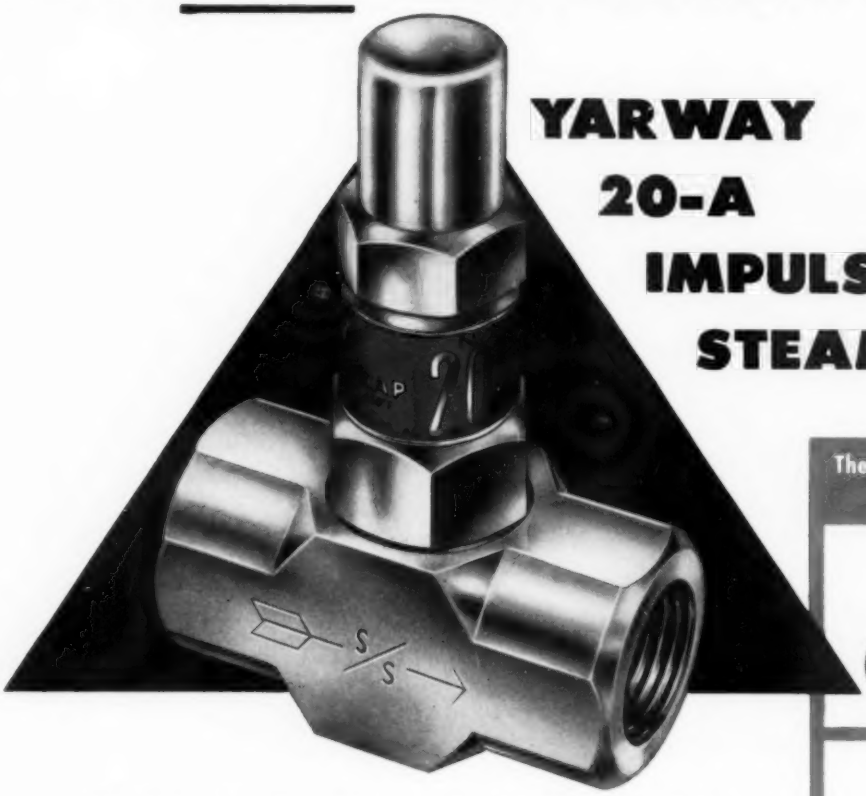
EC&M Contactor lifter raises contactor and overload relay above oil level for easy inspection. No bolts or leads to disconnect.

For literature describing EC&M's complete starter line, write for Bulletin 8131-T

THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

8020

THE RIGHT STEAM TRAP FOR LIGHT CONDENSATE LOADS



YARWAY 20-A IMPULSE STEAM TRAP

● Successful companion to the standard Series 60 YARWAY Impulse Steam Trap, the ½" No. 20-A is right and recommended for *light load* applications in:

REFINERIES, CHEMICAL AND PROCESSING PLANTS on steam tracer lines, meter boxes, steam mains, separators, small dryers, pipe coils, small unit heaters, etc.

POWER PLANTS on headers, fuel oil preheaters, compressed air lines, small steam jacketed fire pumps, etc.

HOSPITALS, SCHOOLS, HOTELS AND INSTITUTIONS on autoclaves, sterilizers, steam tables, washers, small pressure cookers, steam mains, etc.

LAUNDRIES on small presses, puff irons, sock forms, drying cabinets, starch cookers, steam mains, etc.

The 20-A has all the YARWAY Impulse Trap features such as small size, stainless steel body and working parts, low cost, non-freezing—and immediate availability through 270 local Industrial Distributors.

Write for Bulletin T-1739-X.

YARNALL-WARING COMPANY
153 Mermaid Avenue, Philadelphia 18, Pa.

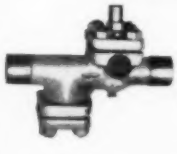
There's a Yarway Impulse Trap for every trapping need

SERIES 60 AND 120
For all *normal* trap requirements, pressures to 400 and 600 psi.

½" No. 20-A
For *light loads* on tracer lines, steam mains, small presses, etc.

SERIES 40
For *heavy loads* requiring extra high capacity steam traps.

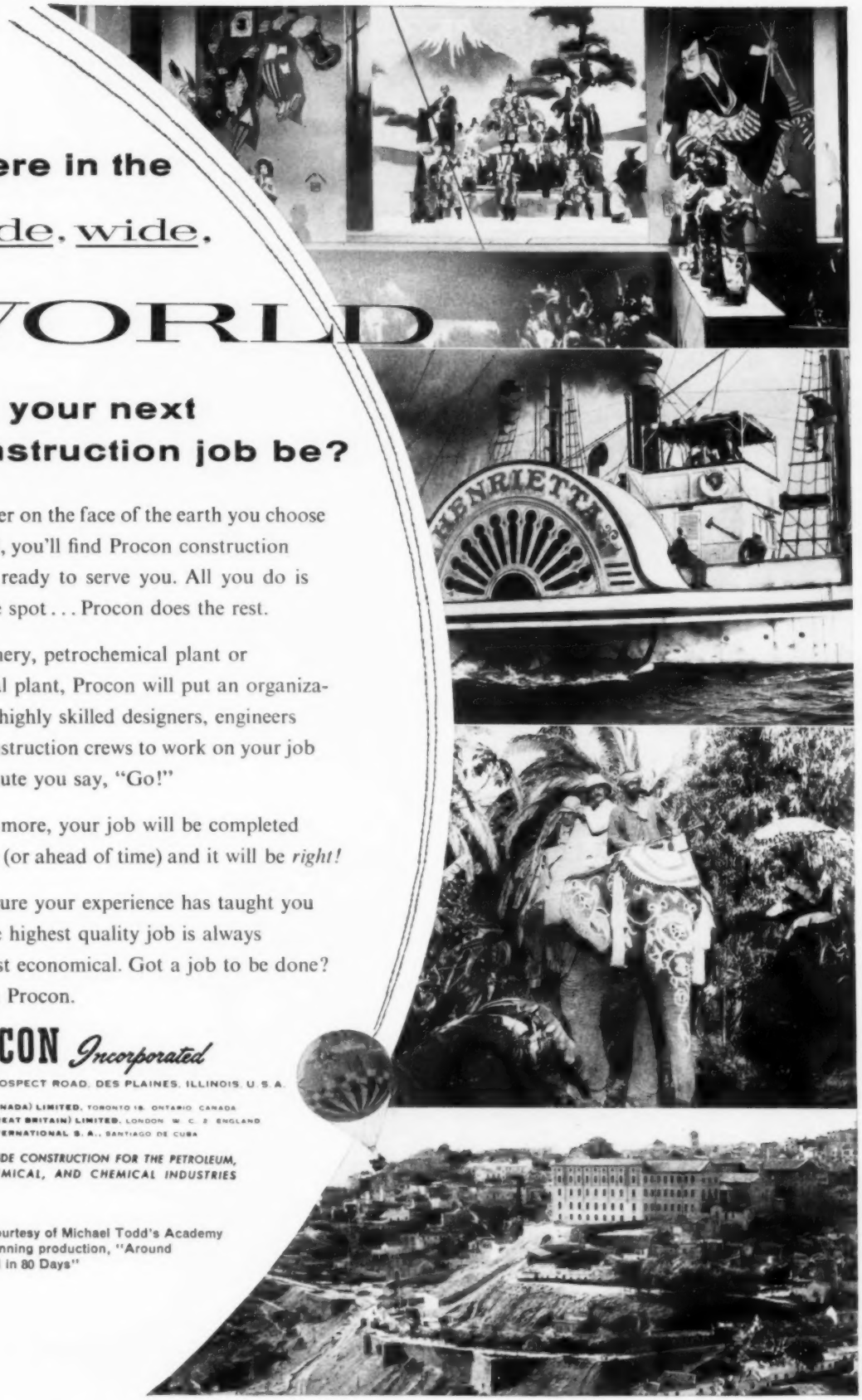
INTEGRAL-STRAINER HIGH PRESSURE TRAP



For *high pressures, high temperatures.* (Flanged or welding connections.)

YARWAY IMPULSE® STEAM TRAP

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED



where in the

wide, wide,

WORLD

will your next construction job be?

Wherever on the face of the earth you choose to build, you'll find Procon construction experts ready to serve you. All you do is pick the spot . . . Procon does the rest.

Oil refinery, petrochemical plant or chemical plant, Procon will put an organization of highly skilled designers, engineers and construction crews to work on your job the minute you say, "Go!"

What's more, your job will be completed on time (or ahead of time) and it will be *right!*

We're sure your experience has taught you that the highest quality job is always the most economical. Got a job to be done? Call on Procon.

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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

Photos courtesy of Michael Todd's Academy Award winning production, "Around the World in 80 Days"

In developing THERMOBESTOS Insulation

J-M at

Low Conductivity. The low thermal conductivity of Thermobestos is best demonstrated in actual service where it makes possible accurate, uniform temperature control, helps reduce fuel costs and contributes materially to operating efficiency.

Not damaged by water. Thermobestos has the moisture resistance outdoor service demands. Soak it in water for one day or 365—and you can still walk on it without damage. Dry it out and Thermobestos is as good as new, with conductivity and structural strength unimpaired.

Johns-Manville

for outdoor process industry applications

research scientists didn't stop top insulating effectiveness...

They added the three physical properties you most wanted— HIGH STRENGTH—LIGHT WEIGHT —MOISTURE RESISTANCE!

Thermobestos® offers the lowest k factor of all insulations in general use throughout the process industries. For maximum heat control on outdoor piping and equipment operating at temperatures to 1200F it just can't be beat!

Yet top insulating effectiveness is only one reason why more and more engineers are specifying Thermobestos for refineries, chemical plants, and wherever hot outdoor vessels and piping must be insulated. For Thermobestos also offers a threefold bonus . . .

. . . Three outstanding physical properties

Thermobestos is 1) strong and rigid. Its hard composition resists crushing and easily withstands unusual service abuse. Yet it is 2) lightweight for easy handling and fast application. And it is 3) highly moisture resistant, remains undamaged even by prolonged wetting.

Quickly, easily applied

Thermobestos is made from hydrous calcium silicate . . . molded to size for proper fit. Its high strength makes it particularly adaptable for time-saving shop prefabrication of fittings and bends.

Furnished in large sections, Thermobestos is easy to apply. It reduces the number of joints. In pipe insulation form, it comes in a complete selection of sizes up to 30″ O. D. Also available in 6″ x 36″ and 12″ x 36″ blocks in a full range of thicknesses.

For further information write for your free copy of the 12-page Thermobestos booklet, IN-169A. Address Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

INSULATIONS FOR LASTING THERMAL EFFICIENCY
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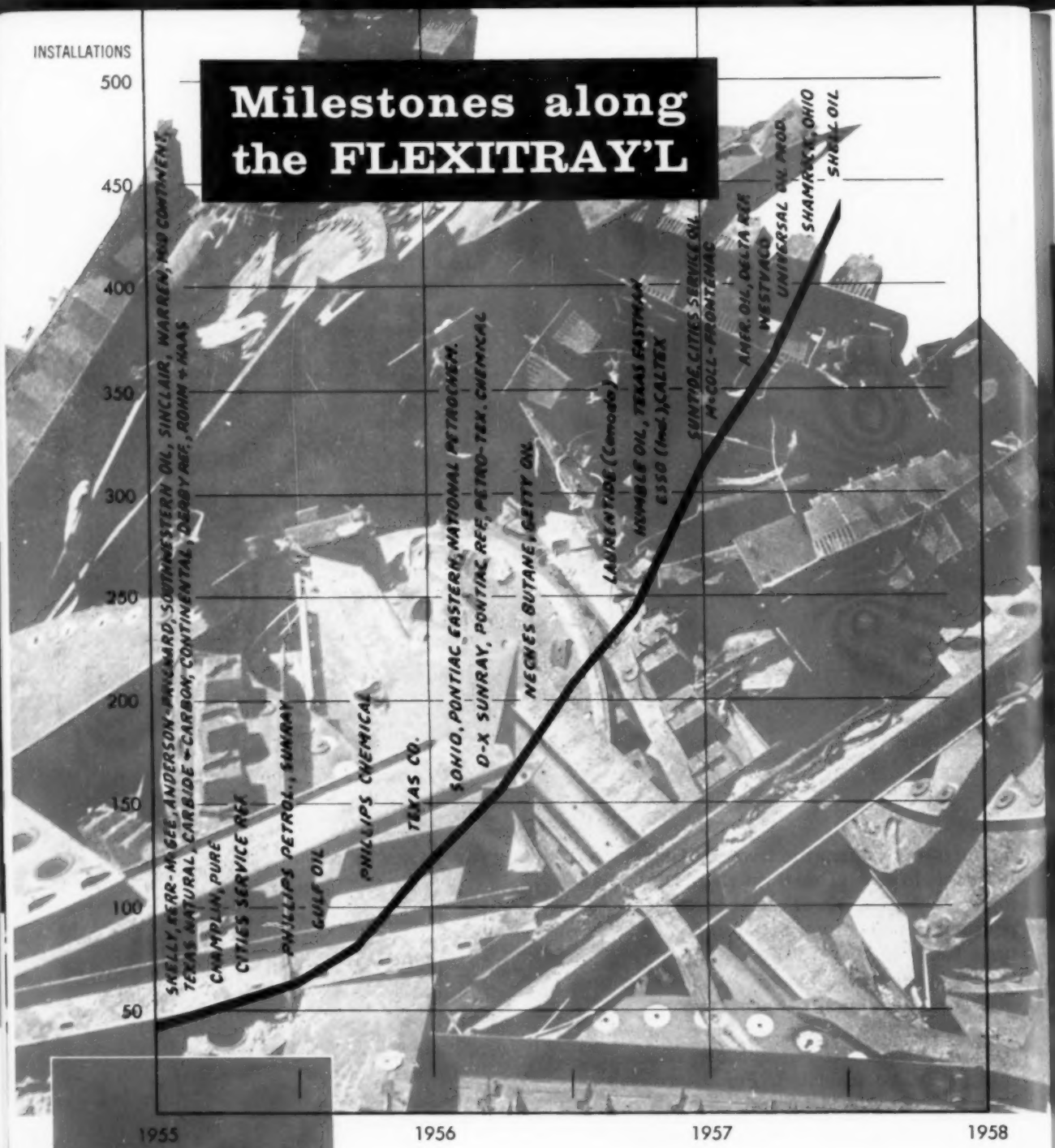
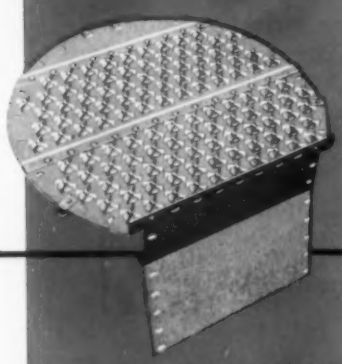
JOHNS-MANVILLE JM PRODUCTS

Milestones along the FLEXITRAY'L



*Dates of original orders only, reorders not shown.



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KOCH ENGINEERING COMPANY, INC.

DESIGNERS AND FABRICATORS OF MODERN TRAYS
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Have You a Special Heat Transfer or Chiller Problem?

My Problem Is Surface Fouling!

Vogt has the answer in the positive *flow-thru* Scraped Surface Exchanger. Surfaces are swept clean by the rotating scraper action, eliminating the headache of fouled heat transfer surfaces.

We Have A Tough Crystallization Problem!

Because Vogt Scraped Surface Exchangers maintain uniform heat transfer rates crystallization is under control at all times. The rotating blades free the crystals from the walls and they are discharged as a slurry.

Our Product Must Be Mixed As It Flows!

Chemical Processors are particularly happy with the Vogt Scraped Surface Exchanger, because the product is thoroughly mixed by the rotating scraper blades as it flows.

Our Solvents are Dangerous to Use-Expensive to Lose!

Vogt Scraped Surface Exchangers are closed, pressure-type systems which permit the use of flammable, volatile and expensive solvents with complete safety and no danger of solvent loss.

Vogt

Has the answer in its

Scraped Surface Exchangers

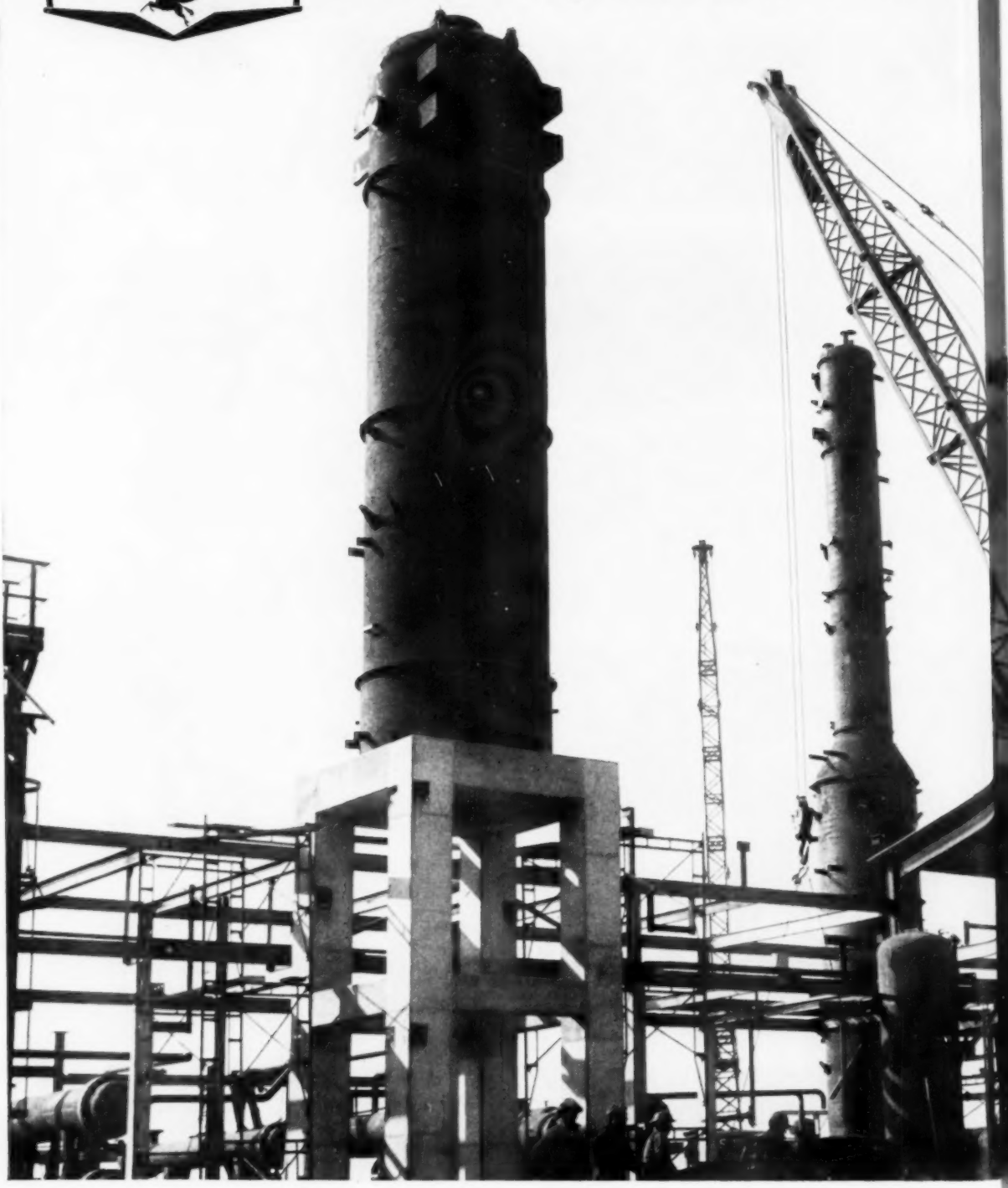
Send for Bulletin PE-1 today. Address Dept. 24A-RIPP.

OTHER VOGT PRODUCTS: Drop Forged Steel Valves, Fittings and Flanges in a complete range of sizes • Petroleum Refinery and Chemical Plant Equipment • Steam Generators • Heat Exchangers • Ice Making and Refrigerating Equipment.

HENRY VOGT MACHINE CO., P. O. BOX 1918, LOUISVILLE 1, KY.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

Mobil Catalytic hydrodesulfurization



This is Lukens clad steel—not a lining, not a soldered-on surface, but a solid plate—one side corrosion resistant metal permanently bonded over-all to a rugged, economical backing steel.

reactor takes Lukens clad and alloy steels

CLAD STEEL STRIPPER, FLASH DRUM ALSO INSURE LONG-RUN ECONOMY, FREEDOM FROM MAINTENANCE

Designers and fabricators for Socony Mobil selected Lukens clad steel to combat corrosion by sulfur compounds . . . even at peak temperatures and pressures at which its new 22,000 bbl. catalytic hydrodesulfurization unit will operate at Paulsboro, N. J.

For the reactor vessel (left) and the top nine feet of the product stripper, Lukens stainless-clad type 321 was specified. ASME heads by Lukens are of the same materials —as is the flash drum.

Of equal importance, the backing of Lukens alloy—A-204 Gr. B carbon moly—resists the creep and hydrogen embrittlement which might otherwise result in this service. Typical temperatures range from 400° to 850°F., at pressures from 50 to 1500 psig. The installation is the first of many which Socony Mobil is planning for making No. 2 fuel oil a more efficient, better burning product.

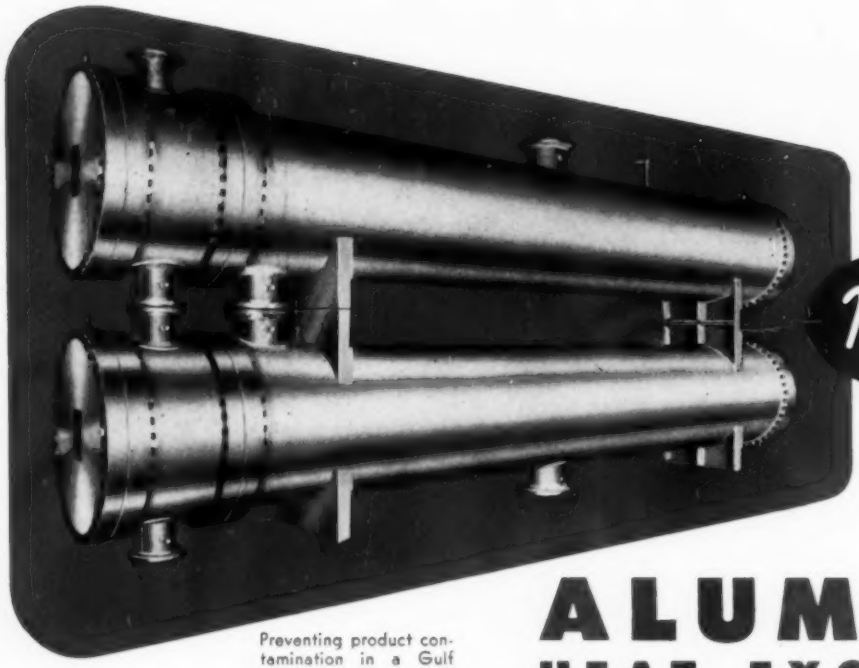
It is another example of how Lukens clad and alloy steels provide maintenance-free corrosion protection at high temperatures and pressures.

Ask your equipment builders, or write for the new **Clad Steel Equipment** bulletin, as well as information on alloy steels. Address Manager, Marketing Service, Room 948, Lukens Steel Company, Coatesville, Pa.

LUKENS ®

Helping industry choose steels that fit the job

 (To obtain more data on advertised products see page 222)

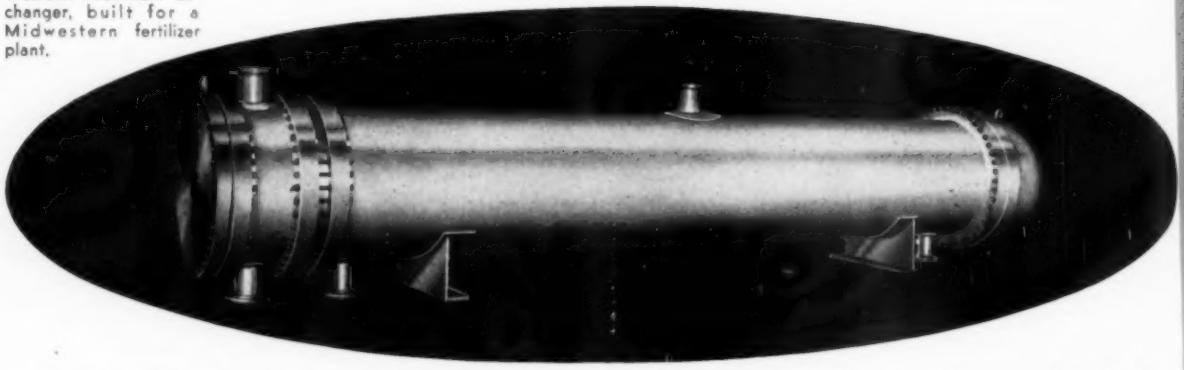


SPECIAL
Metallurgy

ALUMINUM
HEAT EXCHANGERS
from WESTERN

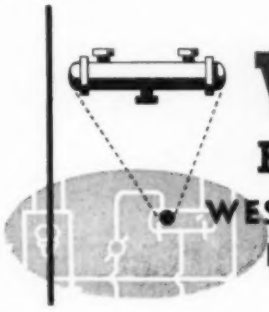
Preventing product contamination in a Gulf Coast high density polyethylene plant is the application for which these Western Aluminum Exchangers were designed.

Corrosion resistance to ammonium nitrate solutions is the job of this Western Aluminum Exchanger, built for a Midwestern fertilizer plant.

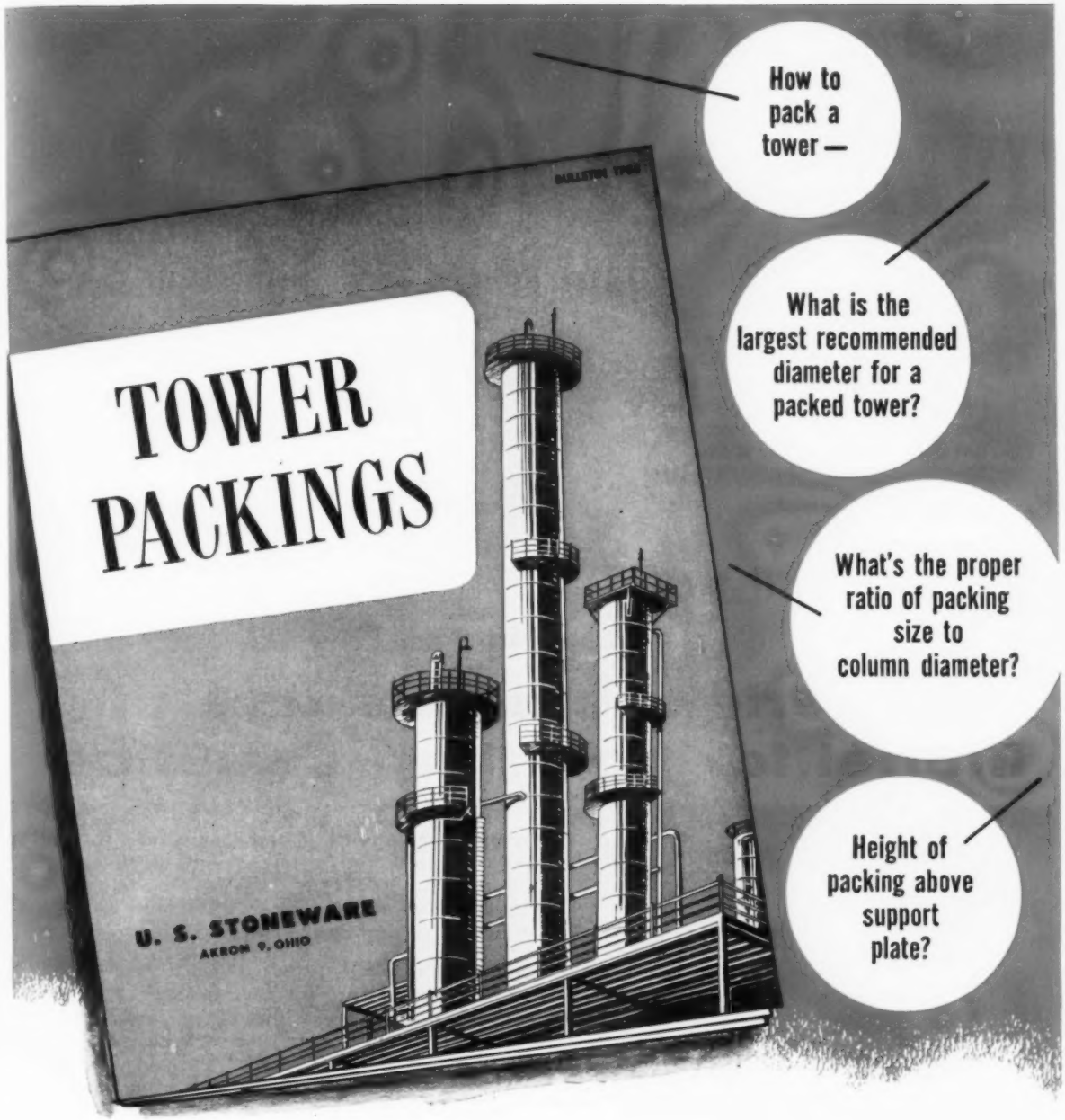


Exemplary of Western's experience in special alloy fabricating are these all-aluminum exchangers—wherein Western's metal inert gas and tungsten inert gas welding equipment, along with other specialized equipment and facilities—are utilized to produce heat exchangers specifically designed for handling specific corrosive fluids. Western's background in special metals has been successfully applied to Austenitic Stainless Steels—High Chrome Irons—Low Chrome Moly Steels—Monel—Copper Silicon—Nickel—and Aluminum.

You can profit from Western's extensive metallurgical experience. All we need is the opportunity.



WESTERN
HEAT EXCHANGERS
WESTERN SUPPLY COMPANY
P. O. Box 1888 – Tulsa, Oklahoma


How to pack a tower —
What is the largest recommended diameter for a packed tower?
What's the proper ratio of packing size to column diameter?
Height of packing above support plate?
BULLETIN TP54
TOWER PACKINGS
U. S. STONEWARE
AKRON 9, OHIO

Such helpful information as this is contained in a new booklet (TP54) which we have prepared to describe the physical and chemical data on Tower Packings. It is free on request to chemical engineers, engineering students and colleges.

Data also includes sizes, surface area, number per cubic foot, percentage of free gas space, etc., on Raschig Rings (ceramic, metal and carbon), Intalox Saddle Packing, Berl Saddles, Lessing Rings, Cross-Partition Rings, Spiral Rings, and Metallic Pall Rings.

Write for it today. Address Dept. CE-857
The U. S. Stoneware Co., Akron 9, Ohio

U. S. STONEWARE
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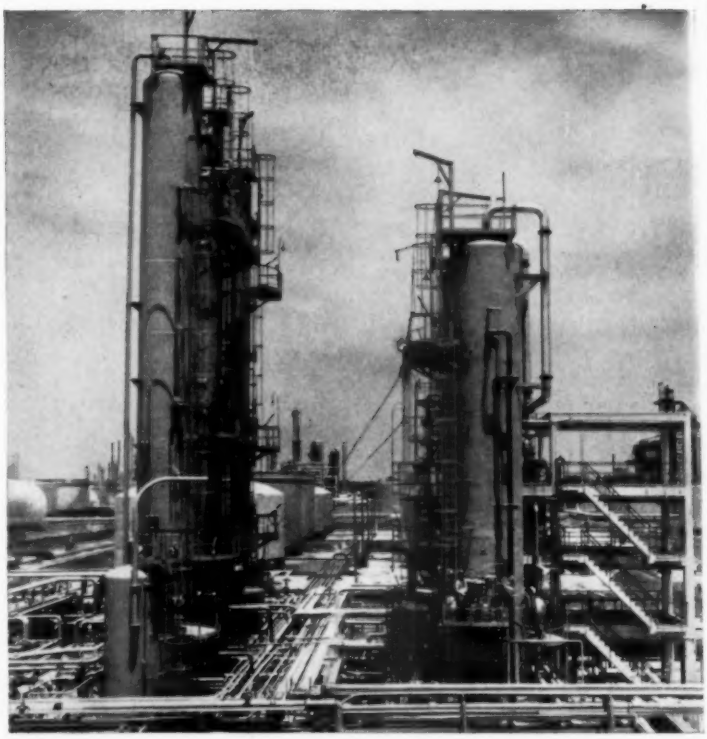
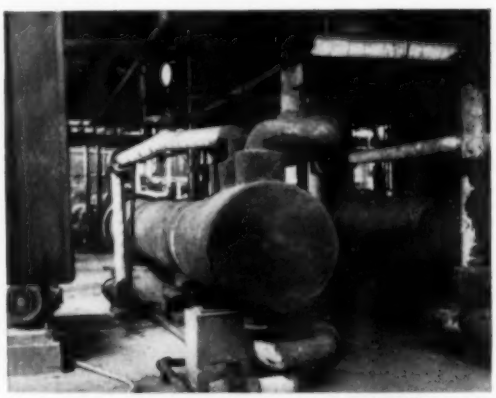
51-F



Take towers — This one is saving a large southern refinery $20,000 a year in maintenance costs. Solid 7/16-in. Monel* nickel-copper alloy walls save the caustic stripping tower in the refinery's Unisol unit from the corrosive bite of 47° Baume caustic at 290° to 300°.

Experience spurs use of Monel for handling caustics



Heat exchangers (left) — Here's a preheater that is exposed to contaminated caustic entering the regenerator tower and to pure caustic leaving. Despite severe conditions, the preheater is giving trouble-free service. Shell and tubes are Monel alloy.

Agitators (lower left) — In this large agitator tank at an eastern refinery, bottoms and sides up to 6 ft. were replaced with Monel alloy. A wise choice. Monel alloy has proved to be the most economical material to use for this service.

Experience like this has led to the use of Monel alloy for a variety of other caustic processing units: reboiler tube bundles, hot caustic lines and caustic storage vessels, to name a few. In petrochemical plants using caustics, Monel alloy guards product purity.

Making available field experience in overcoming caustic corrosion is one of Inco's many services. Why not take advantage of this service? Send us details of your problem and our Research and Development Engineers will work with you to provide a solution.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
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INCO TRADE MARK **Nickel Alloys**

Monel ... *for minimum maintenance*

Now... at 1/10 the cost... a better

ANTI-STALLING ADDITIVE

GULF AGENT 178

... proved by over 25 billion miles of stall-free driving!

GULF AGENT 178 provides economic, effective anti-stalling performance in motor gasolines. At the same time, it affords corrosion protection at no extra cost.

Look at what GULF AGENT 178 offers you:

PROVED PERFORMANCE—GULF AGENT 178—long recognized as an outstanding corrosion inhibitor for all types of petroleum products—is now used by major refiners in modern volatile motor gasolines to eliminate stalling caused by carburetor icing . . . and its effectiveness for this use has been proved in service by over 25 billion miles of stall-free driving.

LOW COST—Small concentrations—15 to 25 pounds per thousand barrels—give anti-stalling protection at as low as 1/10 the cost of commonly used de-icing additives.

EASE OF USE—GULF AGENT 178 is readily soluble in all petroleum products—can be easily blended at temperatures ranging from minus 30 to plus 140° F. Also, it is insoluble in water and can be handled in conventional gasoline transfer systems with no danger of loss from water leaching.

MINIMUM STORAGE—The small concentrations required eliminate need for expensive additive storage.

EXTRA BENEFITS—Rust protection it provides lengthens life of distribution and storage facilities from refinery to customer.

Let us demonstrate GULF AGENT 178 in your gasoline!

Petrochemicals Department
GULF OIL CORPORATION
Gulf Building
Pittsburgh 30, Pennsylvania

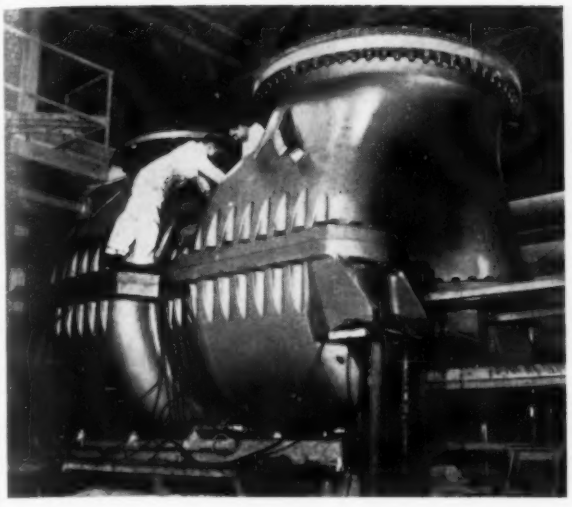
QUALITY CHEMICALS *from* PETROLEUM

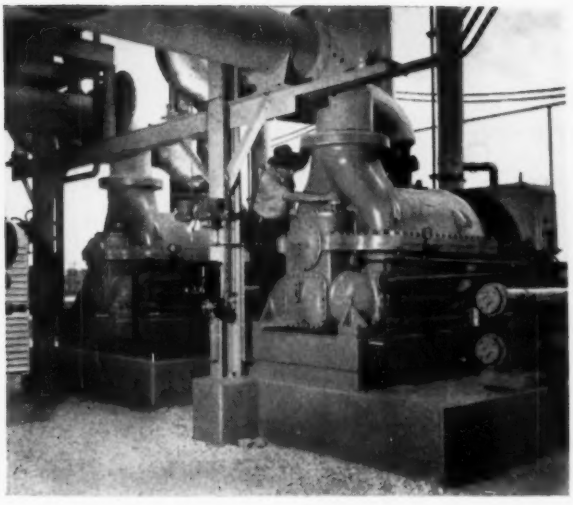
GULF

Which is the best way to process gas?

That depends on the type of gas, its volume, its pressure, and its temperature. The machine that's right for one process may not be the best for another. With the widest selection of equipment in the field for compressing gas or condensing it, Carrier has the right machine for your process. Here are four of them—each fitting different objectives. Only Carrier makes all four and can give you an impartial recommendation. For complete information call your nearest Carrier office. Or write Carrier Corporation, Syracuse, New York.

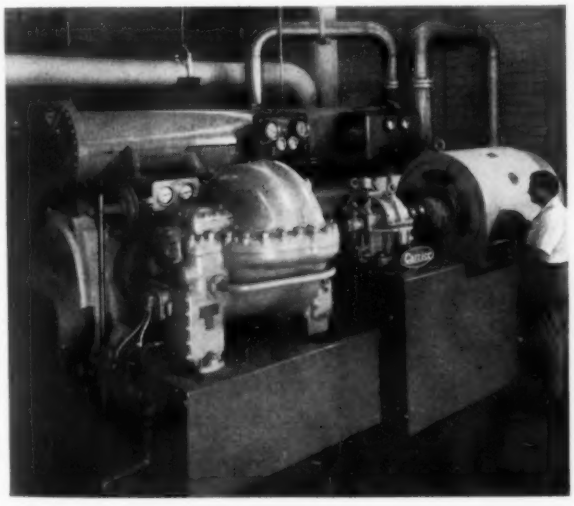
Carrier

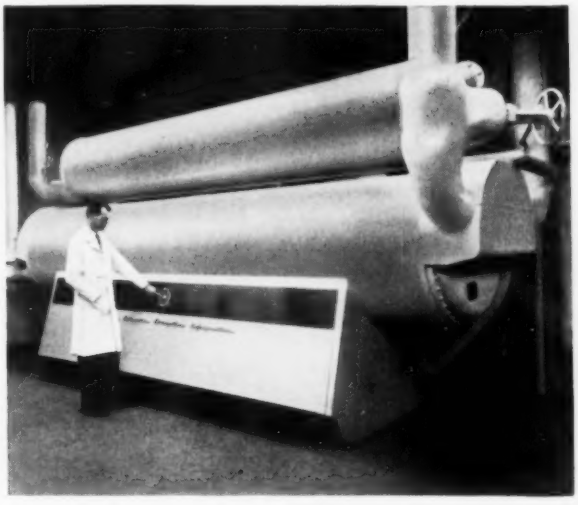




If you need large volume flow, Carrier Axial Flow Compressors offer distinct advantages. Their high efficiency effects a significant reduction in operating costs. And their dependability is proved—the hundreds now in use have given reliable service for a total of 60 million operating hours. Frame sizes are rated up to 600,000 cubic feet per minute when operating on air.

If you need high pressure, Carrier offers a complete line of Centrifugal Compressors for air and gas compression. Their ability to run continuously day in and day out has been demonstrated in many processes in scores of chemical plants and petroleum refineries throughout the world —processes such as catalytic cracking; chemical synthesis; air, gas and oxygen compression.

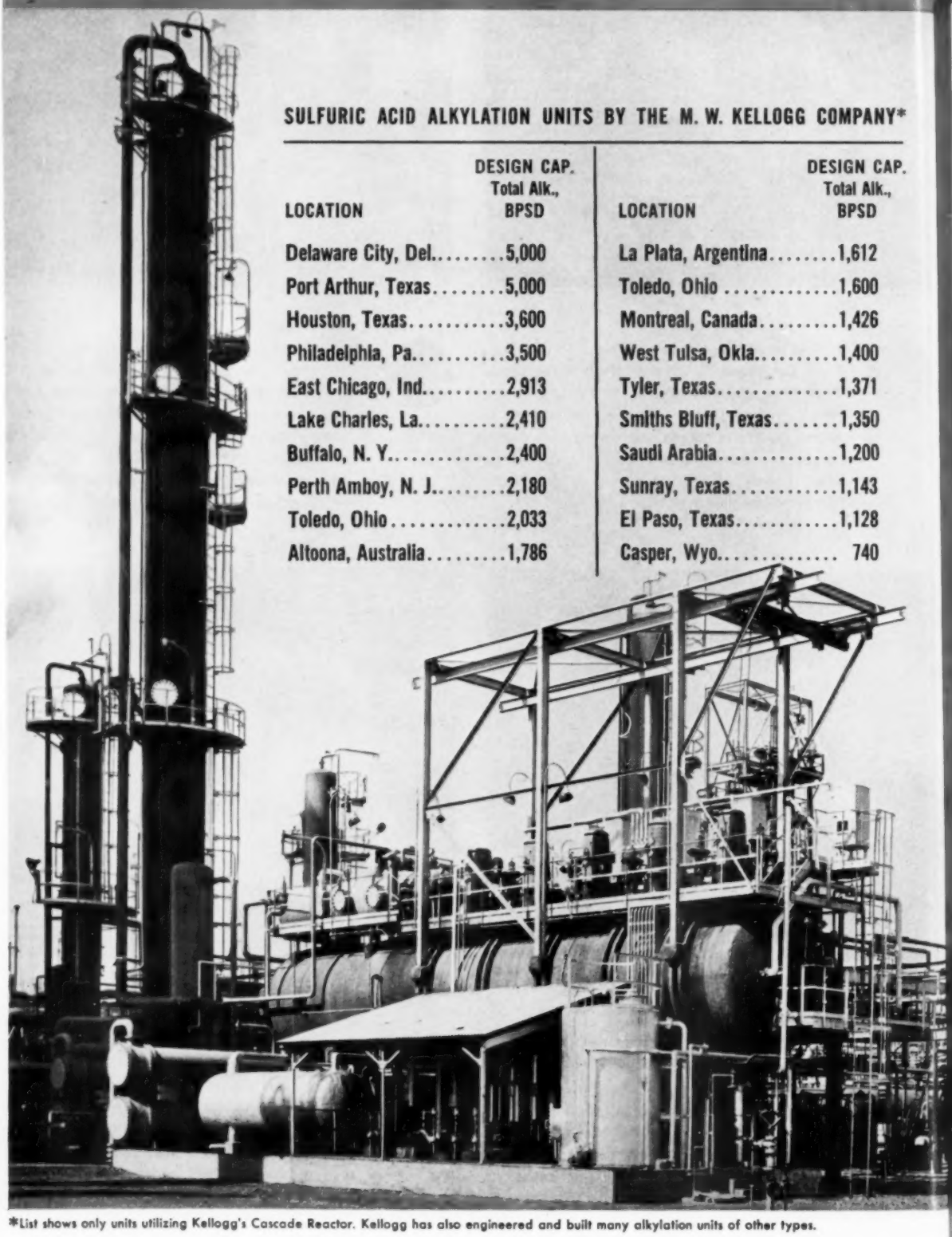




If you need sub-zero refrigeration, Carrier Centrifugal Refrigerating Machines provide accurate, automatic control of temperature 24 hours a day, year around. Besides chilling to ultra-low temperatures, they can be used for petroleum and chemical processes such as lean oil cooling, alkylation, dewaxing, vapor condensing and liquid or brine cooling. Up to 4000-ton capacity.

If you have low-cost steam or hot liquids, Carrier's new Absorption Refrigerating Machines cool water or process streams with heat energy derived from low-pressure waste steam or hot liquids for substantial savings. Operate automatically, follow fluctuating loads from full to zero capacity. Ideal for economical lean oil or chemical solution cooling. Capacities from 60 to 700 tons.

Today's Ultimate



SULFURIC ACID ALKYLATION UNITS BY THE M. W. KELLOGG COMPANY*

LOCATION	DESIGN CAP. Total Alk., BPSD
Delaware City, Del.	5,000
Port Arthur, Texas	5,000
Houston, Texas	3,600
Philadelphia, Pa.	3,500
East Chicago, Ind.	2,913
Lake Charles, La.	2,410
Buffalo, N. Y.	2,400
Perth Amboy, N. J.	2,180
Toledo, Ohio	2,033
Altoona, Australia	1,786
La Plata, Argentina	1,612
Toledo, Ohio	1,600
Montreal, Canada	1,426
West Tulsa, Okla.	1,400
Tyler, Texas	1,371
Smiths Bluff, Texas	1,350
Saudi Arabia	1,200
Sunray, Texas	1,143
El Paso, Texas	1,128
Casper, Wyo.	740

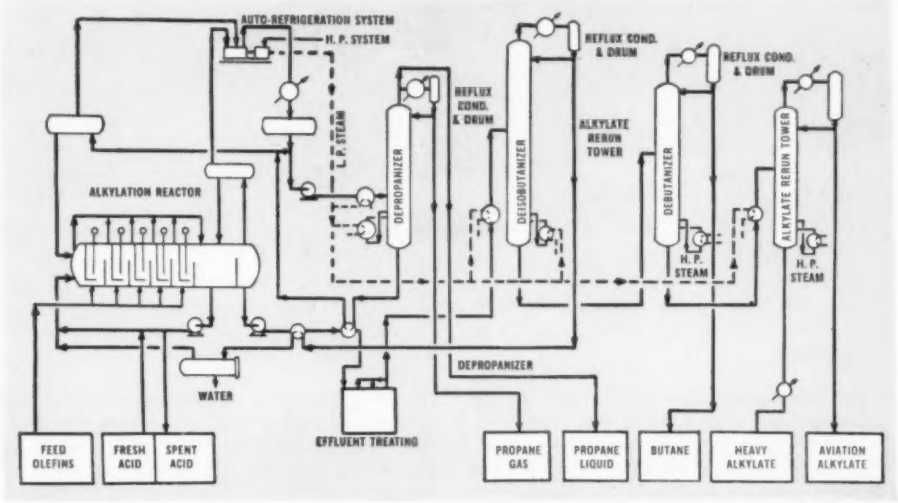
*List shows only units utilizing Kellogg's Cascade Reactor. Kellogg has also engineered and built many alkylation units of other types.

in ALKYLATE . . .

Measured by every standard . . . by quality and quantity of yield . . . by initial investment . . . by operating costs . . . M. W. Kellogg's sulfuric acid alkylation process is bringing optimum results to an increasing number of leading refiners both at home and abroad.

With its present advanced design, utilizing the company's unique multiple-stage cascade reactor and auto-refrigeration system, Kellogg alkylation offers the ultimate today in high isobutane efficiency, low acid consumption, low outlay for recycle and auxiliary equipment, and low utilities cost.

The M. W. Kellogg Company welcomes the opportunity to describe this alkylation process in detail, and to acquaint refiners with the improvements its engineers are continually making toward still greater economy and efficiency.



Refinery Process Division

The M. W. Kellogg Company

711 Third Avenue, New York 17, N.Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York • Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

 (To obtain more data on advertised products see page 222)

how would you like to add $250,000.00 to your profit?

Dowell Chemical Cleaning Made This Possible for an Industrial Plant!

In 1954 an East Coast plant employed Dowell Chemical Cleaning Service on a limited basis. The results were encouraging.

In 1955 the same company expanded its use of chemical cleaning. The results were startling. More throughput, less down time, and greater overall plant efficiency effected nearly a *$250,000.00 saving!*

In 1956 the program was continued. The result: still more savings. Eventually, chemical cleaning on a continuing year-around basis is expected to effect savings of from $300,000.00 to $500,000.00 annually.

This case history is about an oil refinery. However, Dowell has eye-opening performance data to show you in almost any industry.

Dowell engineers are experts in the use of solvents to remove scales and sludges—those deposits that cut the capacity of process and steam generating systems. Dowell does the job for you and furnishes all necessary chemicals, trained personnel, pumping and control equipment.

For additional information, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

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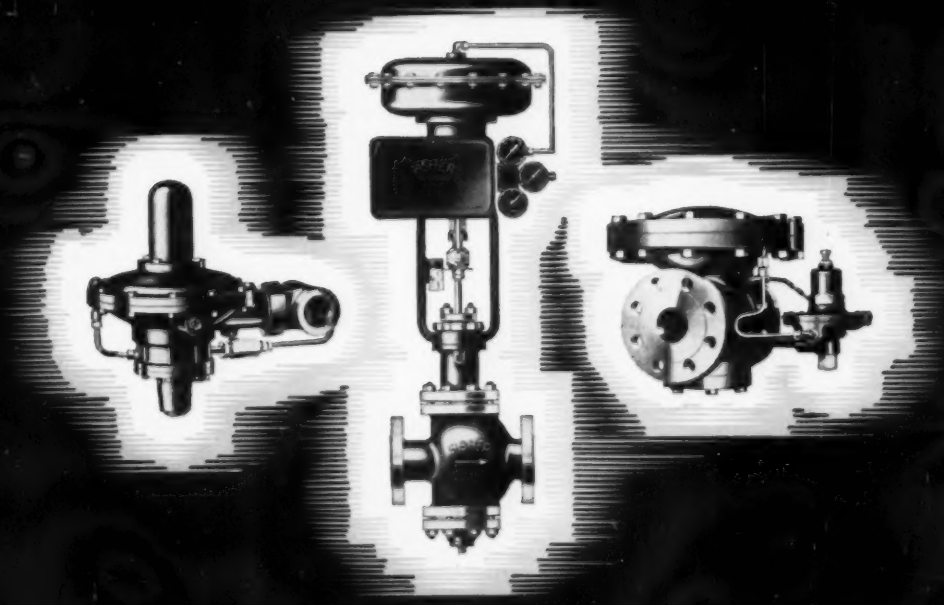
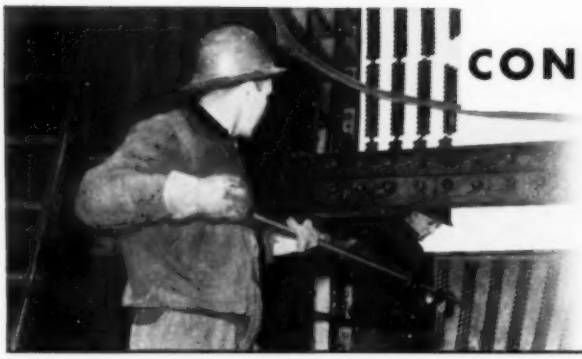
the tough Control Valve jobs go to



FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA • WOODSTOCK, ONTARIO



CONDENSER TUBE CLINIC

Edited by Arthur W. Tracy,
Metallurgical Engineer,
The American Brass Company,
Waterbury, Connecticut

25 Years' Experience has proved the Value of Arsenic as an Inhibitor

Research at The American Brass Company nearly a quarter of a century ago showed that about 0.04% arsenic would inhibit dezincification of brass, and this amount of the element has been added to Admiralty metal and aluminum brass since then.

Inland power stations find that ANACONDA Arsenical Admiralty-439 serves well under normal water conditions, its arsenic content effectively inhibiting dezincification.

Tidewater power stations must contend with much more corrosive waters, and ANACONDA Ambraloy-927, the arsenical aluminum brass, is preferred because it is not only resistant to dezincification but also to impingement or erosion pitting by either clean or polluted sea waters flowing at relatively high velocities.

Oil refineries have virtually made ANACONDA Arsenical Admiralty-439 standard for refinery condensers and heat exchangers handling crudes, rerun stocks, cracked products, lubricating oils, and by-products. It is resistant to dezincification and can handle corrosive cooling waters at relatively high temperatures. Another important property is its ability to withstand attack by sulfur compounds resulting from the refining of sour crudes. ANACONDA Ambraloy-927, because of its resistance to dezincification and to pitting corrosion by sea water at relatively high velocities, is sometimes preferred in oil refineries on tidewater.

Marine users generally find ANACONDA Arsenical Admiralty-439 satisfactory for inland-water vessels and also for seagoing vessels where service conditions are moderate; but ANACONDA Ambraloy-927 is preferred for most seagoing vessels. Both alloys are resistant to dezincification under all corrosive conditions found in these services.

Your own needs may call for these corrosion-resistant Anaconda alloys or they may call for other tube alloys we make. Our Technical Department will be glad to help you select the one best alloy for the conditions you face.

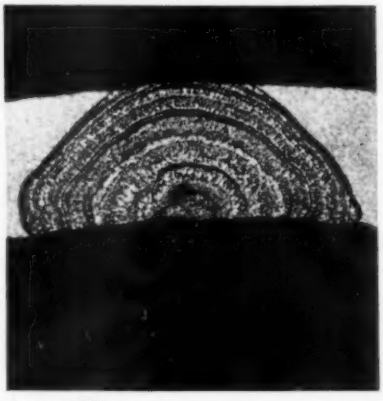
Technical Service—Get full information on our technical services and products by writing The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5676

APPROXIMATE MECHANICAL AND PHYSICAL PROPERTIES
(Light Annealed Tubes)

	Arsenical Admiralty-439	Ambraloy-927
Tensile Strength, psi.	52,000	60,000
Yield Strength, 0.5% Elongation, psi.	22,000	27,000
Elongation in 2", %	60	55
Rockwell Hardness "B"	6-45	35-65
Density, Lb./cu. in.	0.308	0.301
Thermal Conductivity, B.T.U. Sq. Ft./ In./Hr./ °F. at 68°F.	768	696
Coefficient of Linear Expansion, Average per °F. (77°-572°F.)	0.0000112	0.0000108

TWO TYPES OF DEZINCIFICATION IN NONARSENICAL CONDENSER TUBES

(approx. 120X)
LAYER-TYPE DEZINCIFICATION on the inner wall of an uninhibited Admiralty metal tube from an oil refinery using polluted fresh water.



(approx. 17X)
PLUG-TYPE DEZINCIFICATION on the inner wall of an uninhibited Admiralty metal condenser tube from a power plant operating on tidewater.

ANACONDA®
Tubes and Plates for Condensers and Heat Exchangers

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for petroleum additives
for petroleum additives research,
testing and technical service

AMOCO Chemicals Corporation is a new resource for petroleum additives. This new resource is implemented by: (1) extensive research facilities for the development of improved additive chemicals, (2) engine test laboratories to help evaluate the performance of your motor oils, (3) men fully qualified through experience to cooperate with you in laboratory and field test programs.

AMOCO Chemicals sales engineers have had years of experience in the proper application of petroleum additives. They are ready to assist you in formulating motor oils to meet the requirements you have established for your products.

Want more information about the petroleum additives research, test or technical service facilities of AMOCO Chemicals? Your request for additional information will receive immediate attention.

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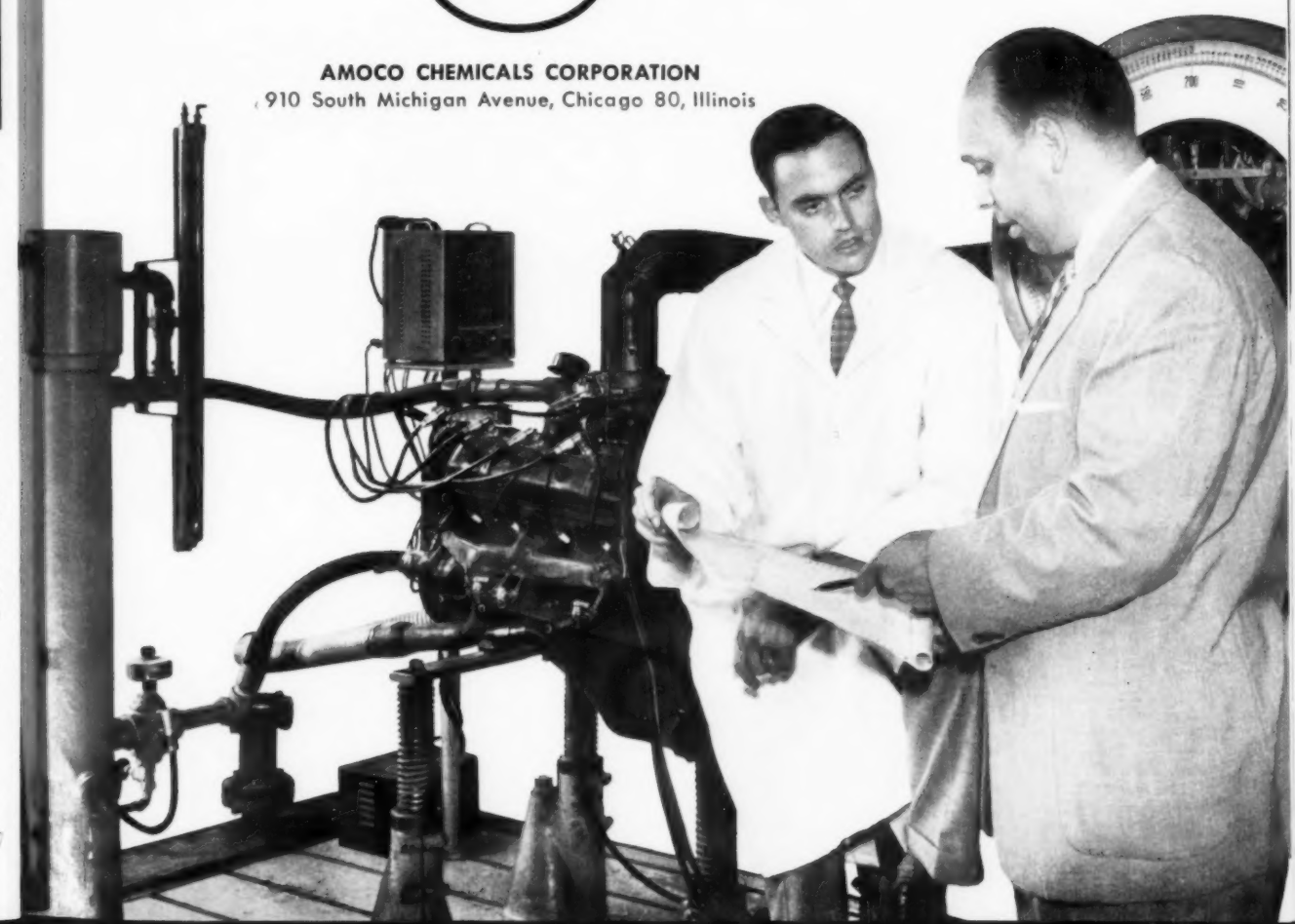
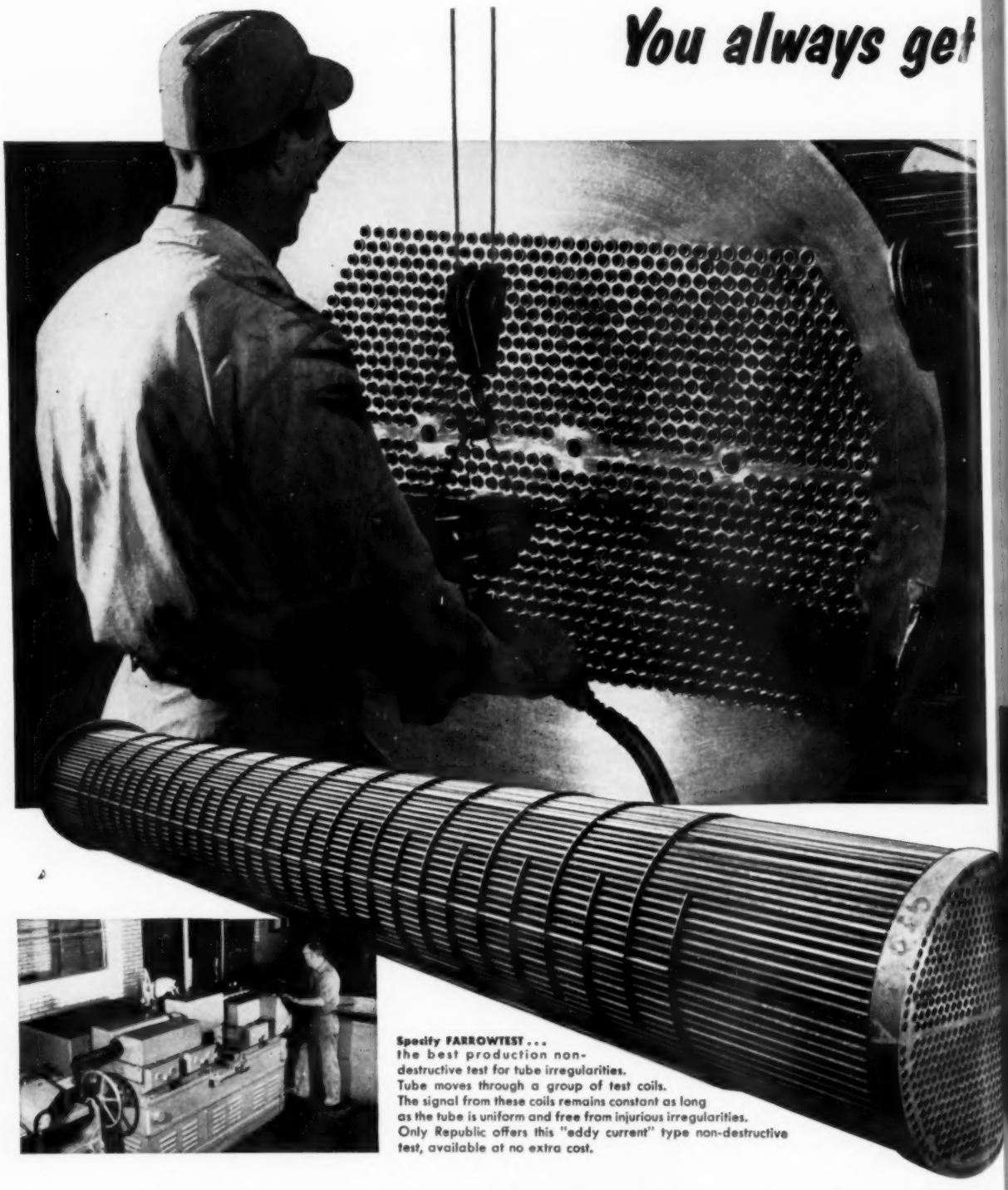
CHEMICALS

AMOCO CHEMICALS CORPORATION
910 South Michigan Avenue, Chicago 80, Illinois



You always get



Specify FARROWTEST . . .
the best production non-destructive test for tube irregularities.
Tube moves through a group of test coils.
The signal from these coils remains constant as long as the tube is uniform and free from injurious irregularities.
Only Republic offers this "eddy current" type non-destructive test, available at no extra cost.

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REPUBLIC STEEL

World's Widest Range of Standard Steels

dependable uniformity when you roll-in

Republic ELECTRUNITE

HEAT EXCHANGER TUBES

Ready . . . set . . . roll-in Republic ELECTRUNITE® Heat Exchanger Tubes for easier, economical installations every time. ELECTRUNITE Heat Exchanger Tubes bend without wrinkling—slide effortlessly into tube sheets—roll-in without fracturing.

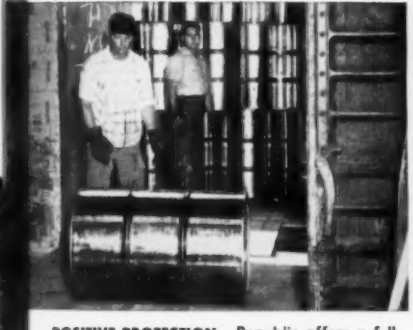
Republic ELECTRUNITE Heat Exchanger Tubes are formed from flat-rolled high quality open hearth steel which is carefully checked for chemical analysis, physical properties, exact thickness and width. Each tube is *electrically-welded* and normalized above the upper critical limit to relieve stresses and improve grain structure.

The results are uniform ductility that accounts for predictable expansion and dependability to conform to applicable code requirements. And this dependable on-the-job performance is so important to petroleum and petro-chemical processing operations.

Finally, each length of carbon steel ELECTRUNITE Heat Exchanger Tube is hydrostatically tested. Or you can specify Republic's exclusive FARROWTEST® . . . a non-destructive electronic testing method that safeguards tubing for critical uses. ELECTRUNITE Carbon Steel Tubes meet all the requirements of A.S.T.M. Specification A-214, or applicable customer specifications.

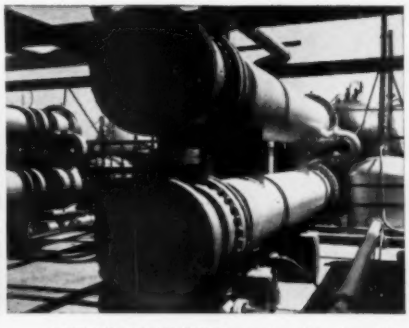
Full finished ELECTRUNITE Stainless Steel Heat Exchanger Tubes conform to the requirements of A.S.T.M. Specification A-249 or A-269.

For complete information, send coupon today.



POSITIVE PROTECTION—Republic offers a full range of barrels, drums and pails in many styles and sizes up to 55 gallons—ENDURO® Stainless Steel, hot-dipped galvanized and tinned steels, mill galvanized sheet, hot-rolled open hearth steel—plain or lacquered, painted or decorated exteriors. Send coupon today.

BUBBLE CAPS made of Republic ENDURO Stainless Steel discourage coking and fouling. Towers stay on stream longer. ENDURO's high strength-to-weight ratio and ease of fabrication permit thinner, lighter sections with more teeth per cap. Stainless steel caps and trays assure sharper fractionation. For data, send coupon today.



REPUBLIC ALLOY STUDS provide the strength needed in high pressure equipment. High tensile strength with tough threads offers maximum holding power and resistance to wear. They tighten smoothly, back-off easily for better equipment maintenance. Over 20,000 fasteners to meet every requirement. See your distributor.

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Carbon ☐ Stainless ☐
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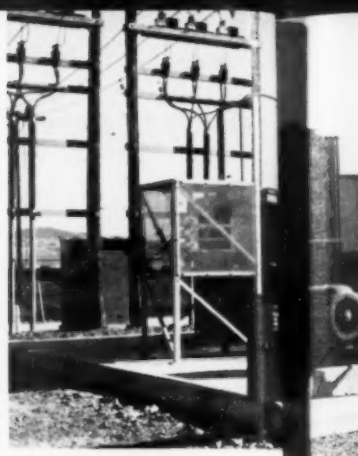
STEEL

and Steel Products

BUILT IN 14 MONTHS by The M. W. Kellogg Co., new ammonia plant is a unit of Standard's Richmond refinery, one of West's largest. All electric equipment is by General Electric, which also provided engineering service to help achieve fast start-up.

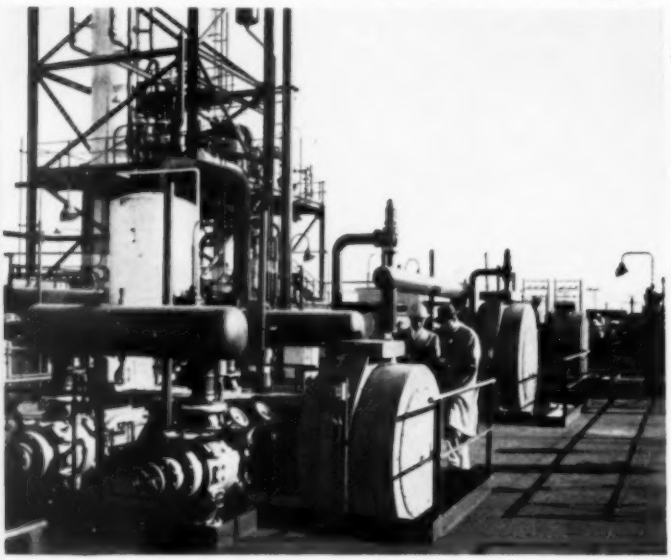


CO-ORDINATED for top reliability, G-E equipment in master substation for ammonia

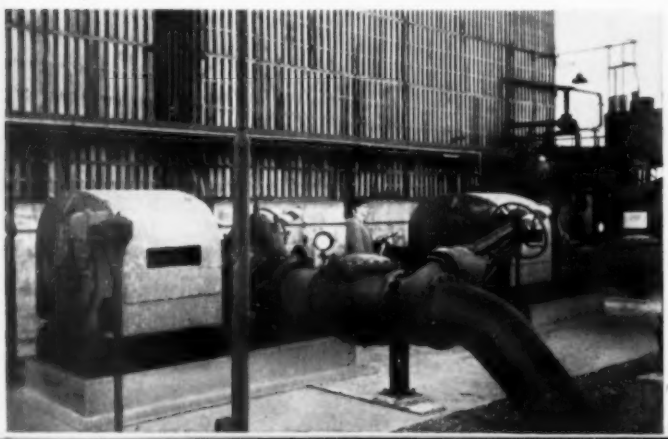
At Standard's Richmond, Calif., refinery . . .

General Electric engineering services help

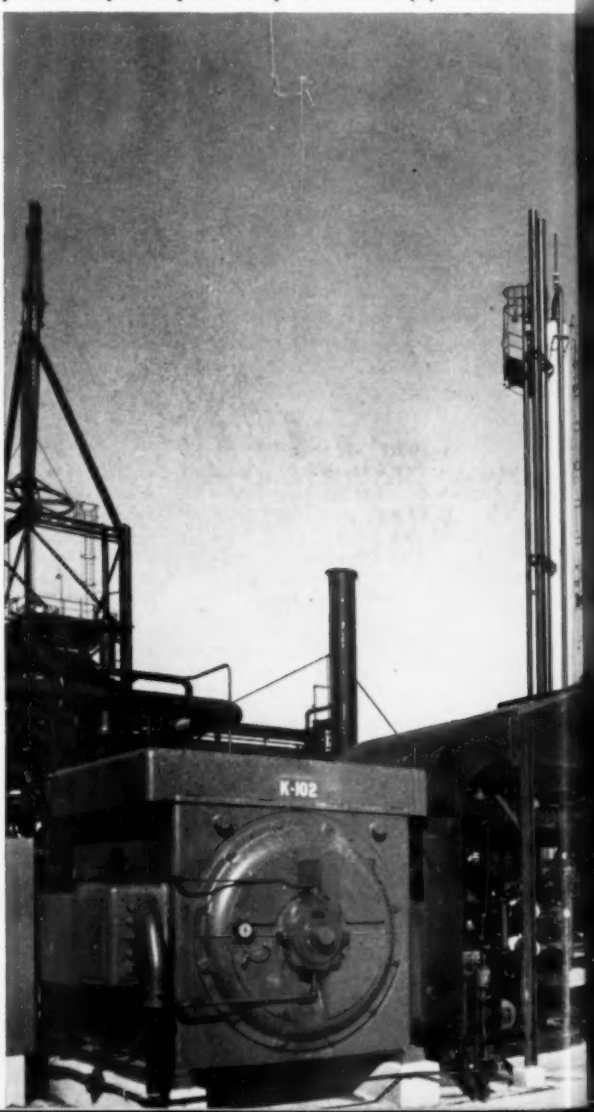
OUTDOOR-LOCATED on platform to drive compressors are 8 high-efficiency, enclosed, force-ventilated G-E synchronous motors (3 shown) with excitation obtained from substation's d-c m-g sets.

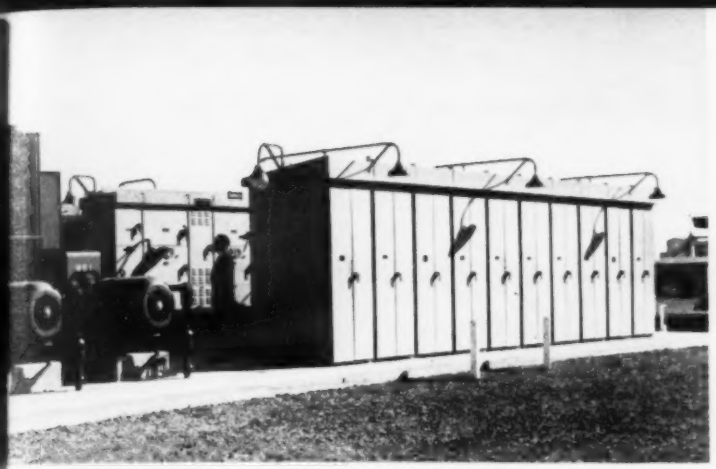


WEATHER-PROTECTED, 2 rugged 350-hp G-E induction motors drive cooling-water pumps. Other plant induction motors are either enclosed force-ventilated or explosion-proof, fan-cooled.



PLANT'S BIGGEST, a 4000-hp 12,000-v totally enclosed force-ventilated G-E induction motor drives synthesis gas compressor. Explosion-proof 60-hp G-E motor (r.) drives blower





plant includes 5000-kva transformer, 17 units of 12-kv metal-clad switchgear, 2300-v Limitamp* motor starters, 480-v outdoor motor control centers, 2 outdoor motor-generator sets, and two 480-v transformers.

*Registered trade-mark of General Electric Co.

EASY MAINTENANCE of plant's G-E metal-clad switchgear is shown by workman removing vertical-lift, magne-blast circuit breaker for inspection.

speed opening of 300-ton/day ammonia plant

drawing clean air—via black ductwork and mushroom tower—from upper level of uncontaminated atmosphere.

General Electric power system, installed to meet rigid construction schedule, helps plant get fast start on profitable production

Standard Oil Company of California, Western Operations, Inc., recently added to its Richmond, California refinery—the largest west of the Rockies—a new $11 million ammonia plant designed, engineered and built by The M. W. Kellogg Co. The plant's capacity of approximately 300 tons per day of anhydrous and aqueous ammonia is shipped to nearby California Spray Chemical Corp., a subsidiary, for conversion into fertilizer.

GENERAL ELECTRIC supplied the new plant's electric equipment—compressor drives, auxiliary motors, and complete outdoor substation with co-ordinated components. In addition, General Electric engineering services helped both customer and designer get the new plant from the discussion stage to on-stream in only 14 months.

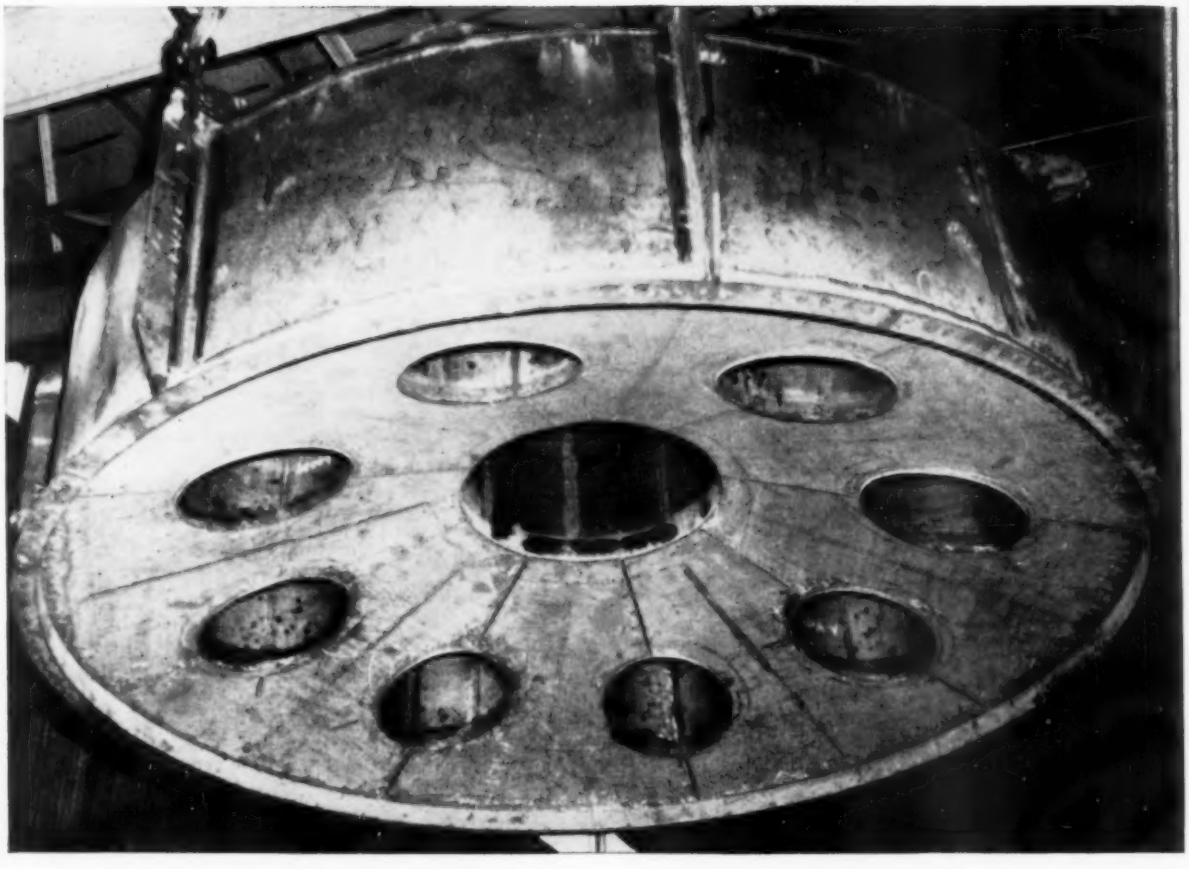
An example was the contribution of General Electric installation and field service engineers. By supervising the installation of the electric equipment as scheduled deliveries arrived, they helped reduce field installation costs, speed completion of construction schedules, and hasten start-up time. To Standard, this meant getting into production faster, and thereby, showing a return sooner on the large capital investment tied up in the plant.

IN ADDITION, the 17,000-kva block of power will be integrated into the existing plant system. General Electric application engineering services, working closely with Standard and Kellogg representatives, helped provide the electrical equipment co-ordination and integration necessary to meet the plant's process power requirements.

For *your* new chemical plant, too, General Electric offers a one-manufacturer source of quality electric equipment and valuable engineering services to help provide you and your process contractor with an efficient, co-ordinated electrical system. Early in your planning, contact your nearest General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y. 662-49

Engineered Electrical Systems for the Process Industries

GENERAL ELECTRIC



Hat size 240

Talk about ten gallon hats, here's a lid for a vaporizer that measures twenty feet in diameter. There were special problems of tailoring. There had to be stainless steel where the vapors flow to resist corrosion, and a carbon jacket to contain steam for heating.

The dome on top of this vaporizer acts as an inverted funnel. The holes you see in the dome are the outlets for the corrosive vapors. With an injection of steam, in the jacketed area of the dome, these vapors are re-heated to keep them in a gaseous state 'til they reach the next step in process.

More users and designers of process equipment are utilizing the "know-how" available at Chicago Steel Tank Company. This "know-how" assures you of a high-quality product at minimum cost whether your needs require fabrication from stainless steels, aluminum, nickel or any other alloy.

When you are anticipating the need for fabricated products, our sales engineers and engineering department are at your service.

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DU PONT *Petroleum Chemicals* NEWS

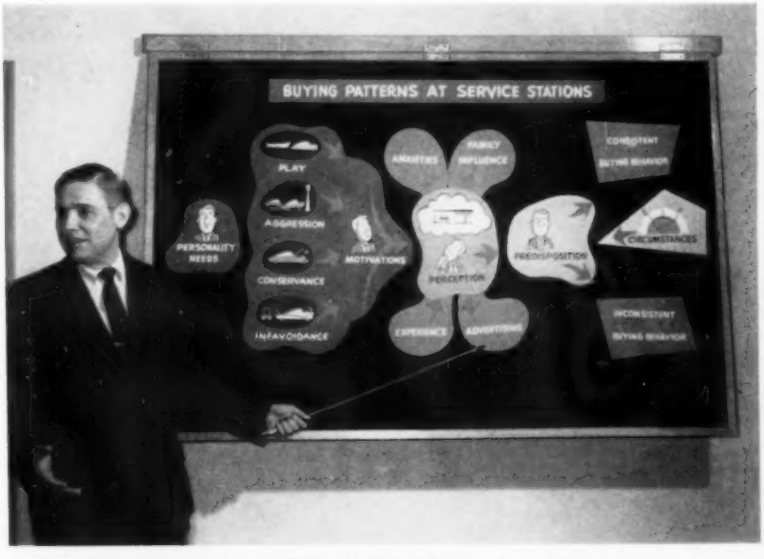
Number 79 in a Series of Bulletins for the Petroleum Industry

SEPTEMBER 1957

New survey reveals hidden buying motivations of service station customers

Still another in a series of Du Pont-sponsored surveys has recently been completed by National Analysts, Inc. The findings will soon be available in booklet form.

The objective of the survey was to determine what emotional reactions influence motorists to choose a service station, a brand of gasoline, or a TBA product.



THE NEW DU PONT MOTIVATION SURVEY REPORT has been packaged as a convenient flannelboard presentation. Roberts W. Brokaw, of Petroleum Chemicals Sales Promotion, demonstrates here how the results can be presented at meetings in easy-to-understand form.

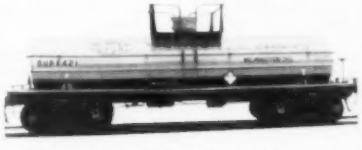
Psychological needs

The psychologists in conducting the study determined that there are four basic needs which can be fulfilled through purchase of service station products and services:

1. **Play**—use of car for recreation

Refiners realize substantial savings by purchasing additives in quantity

If you are now buying your additives in drums, you can *save well over a thousand dollars each time you order* a Du Pont additive by the tank car.



With Du Pont Fuel Oil Additive No. 2, for example, a Mid-Continent refiner can save 8.4% on a carload by simply taking delivery in a 4000-gallon tank car instead of an equal quantity in partial car drum shipments. With Du Pont Antioxidant No. 22, the savings range as high as 8.9%.

These figures are, of course, based on freight rates between specific points, and the savings vary according to the shipping distances.

How much can YOU save?

To answer that question for you, one of our representatives will be glad to call at your refinery and study applicable freight rates and inventory patterns. He will then determine the most convenient handling method for you, and figure the exact saving you can make.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

CONTINUED

New Survey

2. **Aggression**—desire for speed and fast acceleration
3. **Conservance**—need to preserve car as an investment
4. **Infavoidance**—the desire to avoid the *appearance* of inferiority

Specific products

Gasoline sales, as you might suspect, are most influenced by the play and aggression needs. This finding indicates that gasoline advertising should appeal to motorists' desire for recreation and powerful car performance.

It was found that motor oil and grease satisfy the conservance need. The promotion of these products should be directed accordingly. Body polish, which might be thought to satisfy the conservance need, actually gratifies more often the need for infavoidance. So do white sidewall tires.

Anxiety influences

Two of the areas explored were anxieties about product quality and service.

Apparently women drivers are more concerned than men about tire quality and repair. This may be because a flat tire is a greater inconvenience to women.

Women appear to have also a more generalized anxiety over automotive products they buy. This is possibly due to their having, in general, less mechanical knowledge than men.

Perceptions of service stations

Motivational needs lead to motorists' perception of different service stations as places to do business. Perception is influenced also by the opinions of others, including families, and by advertising and promotion of the dealer or the company he represents.

A summary of the findings of the survey are being published in book form for easy reference.

AUTOMOTIVE SERVICE OFFERED

I. T. (TED) ROSENLUND (right) says that actual under-the-hood technical service work on refiners' automotive problems is his greatest source of new ideas. And many of his ideas have resulted in unique demonstration equipment which enables refiners and marketers to prove their product quality to dealers and customers.

He is responsible for the design and construction of practical demonstration equipment for the Petroleum Chemicals Division. This equipment must make somewhat intangible fuel and lubricant properties come to life in the form of noise or motion. With it petroleum refiners and marketers can show their dealers and customers the quality built into their products.

Wide experience

Ted's long experience in automotive service work also enables him to assist in resolving particularly difficult problems as they arise.

Ted joined the DuPont Company in 1947 as manager of the Petroleum Chemicals Division's road test laboratory. Between 1942 and 1947, he had been fuel and lubrication engineer for the Allison Division of General Motors and a project engineer on combustion chamber design and development at the Packard Motor Car Company's jet engine division. Prior to 1942, he spent several years with a major oil company as research engineer on aircraft engine oil development.

Ted graduated from the University of Michigan with a BS degree in aeronautical engineering, majoring in engine design. He is a member of the Society of Automotive Engineers.

Expanded additives warehouse to serve Pacific Northwest area

The DuPont Petroleum Chemicals Division recently expanded its additives warehouse near Seattle.

Ideally located to serve the fast-growing refinery industry in the Pacific Northwest, it will continuously house an ample supply of all DuPont petroleum additives (except tetraethyl lead). The complete DuPont line includes Fuel Oil Additive No. 2, DuPont Metal Deactivator, dyes, antioxidants, and grease additives.

For fast deliveries

Arrangements with a local truck line plus the permanent warehouse staff will help considerably to expedite deliveries of DuPont additives to refiners.

DuPont TEL is supplied to refiners in this area from a DuPont "warehouse on wheels" at Ferndale, Washington.

SALES OFFICES

Chicago 3—8 So. Michigan Ave. RAndolph 6-8630
Cleveland 15—25 Prospect Ave. SUperior 1-1363
Denver 2—Petroleum Club Building, 16th & Broadway AComa 2-2347
Houston 2—705 Bank of Commerce Bldg. CApitol 5-1151
Los Angeles 17—612 So. Flower St. MAdison 5-1691
New York 20—1270 Ave. of the Americas COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza LOcust 8-3531
Pittsburgh 22—1 Gateway Center ATlantic 1-2933
San Francisco 4—111 Sutter St. EXbrook 2-6230
Seattle 3—4003 Aurora Ave. MElrose 6977
Tulsa 1—1811 So. Baltimore Ave. LUther 5-5578
In Canada—DuPont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**—Ontario HUdson 1-6461
In Other Countries—Organic Chemicals Department, Export Division, 7447 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962.

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OVER

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CONTRACT ENGINEERING with a difference

from initial negotiations . . . to "on stream" you deal with Badger principals

You first make contact with Badger through a Key Man as he works with you and your engineering staff in pinpointing your processing and economic problems.

The Key Man, acting in your behalf, takes your problem to Badger engineering specialists for preliminary study and evaluation.

With recommendations approved and construction underway, the Badger Key Man is still on the spot coordinating activities. He remains in charge until your project is complete.

AN engineering project handled by Badger is a group effort involving many highly developed skills. And from first contact until the project is complete these experienced specialists are headed by a Badger Key Man. More than just a sales engineer, he is always a Badger principal — always the Key Man in the execution of the project.

This sensible operating policy, which channels project liaison, coordination and administration through a company principal, is important to you and your project. You will find that most policy level decisions can be made on the spot as situations require. Further, the Key Man's depth of experience means you deal with an executive-engineer who talks your language — knows your problems and how to find their solutions.

Many clients say Key Man Policy is the Badger difference that makes the difference. Wouldn't it be wise to inquire how it could serve to make your projects more successful?

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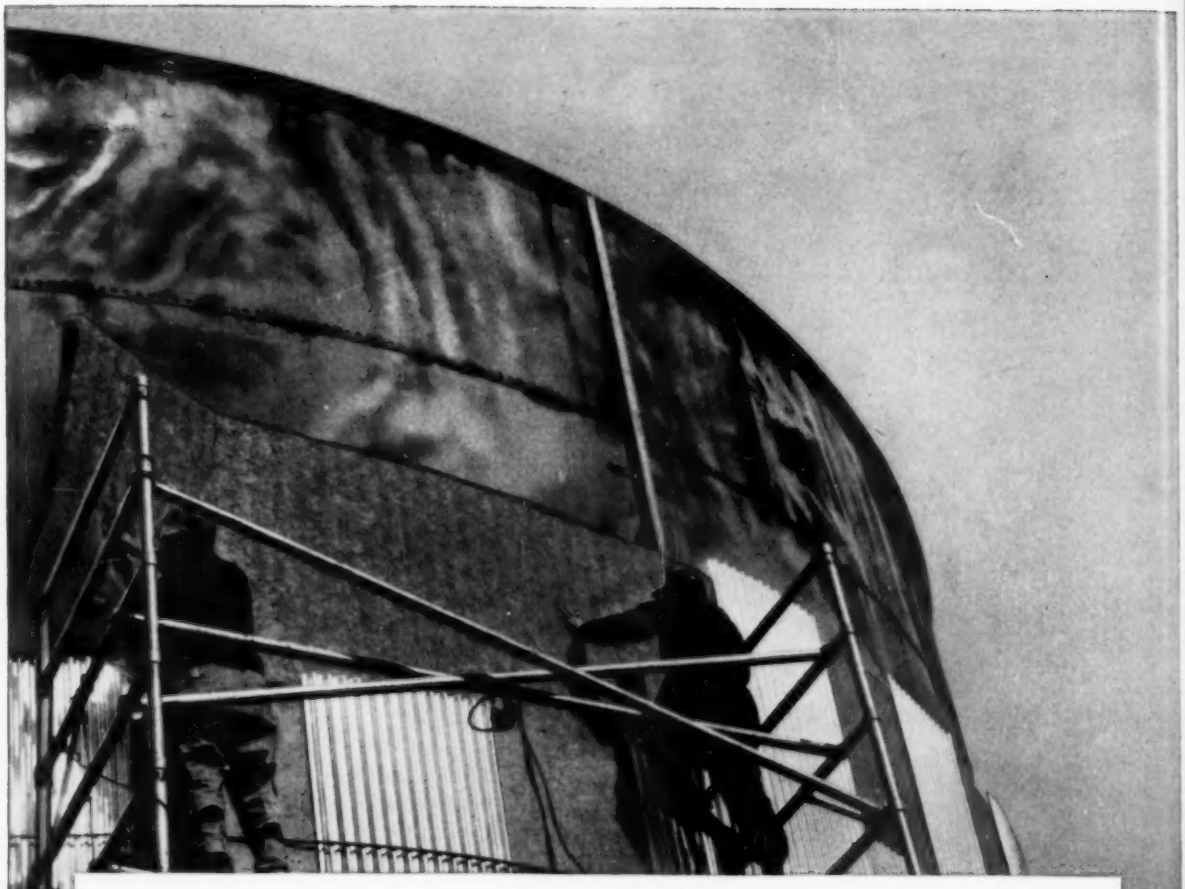


A "deluxe job"—at low cost—with ULTRALITE insulation

Before Ultralite, insulating a tank meant laborious laying up of block after block or batts and more batts all wired together or banded in place with a resulting high insulation cost and many more joints to leak heat. Weatherproofing the completed job with metal made it prohibitively high. But now, Ultralite lowers the cost of insulating so substantially that insulation *plus* metal weatherproofing is a low cost operation; you can have a "deluxe job"—maintenance free, at reasonable cost.

Ultralite saves material handling costs and speeds up application in many ways.

1. Large sections of tank can be insulated at one time with wide continuous blankets of Ultralite, the long glass fiber insulation. In fact Ultralite can be furnished in blanket rolls up to *10 ft. wide* and single thicknesses of 6".

2. Ultralite cannot be damaged due to rough handling — will not lose thickness, break or shrink because it is tough and resilient.

3. Fewer fastening members are required because Ultralite is light weight.

4. Ultralite is shipped to the job in compressed rolls — takes up less space.

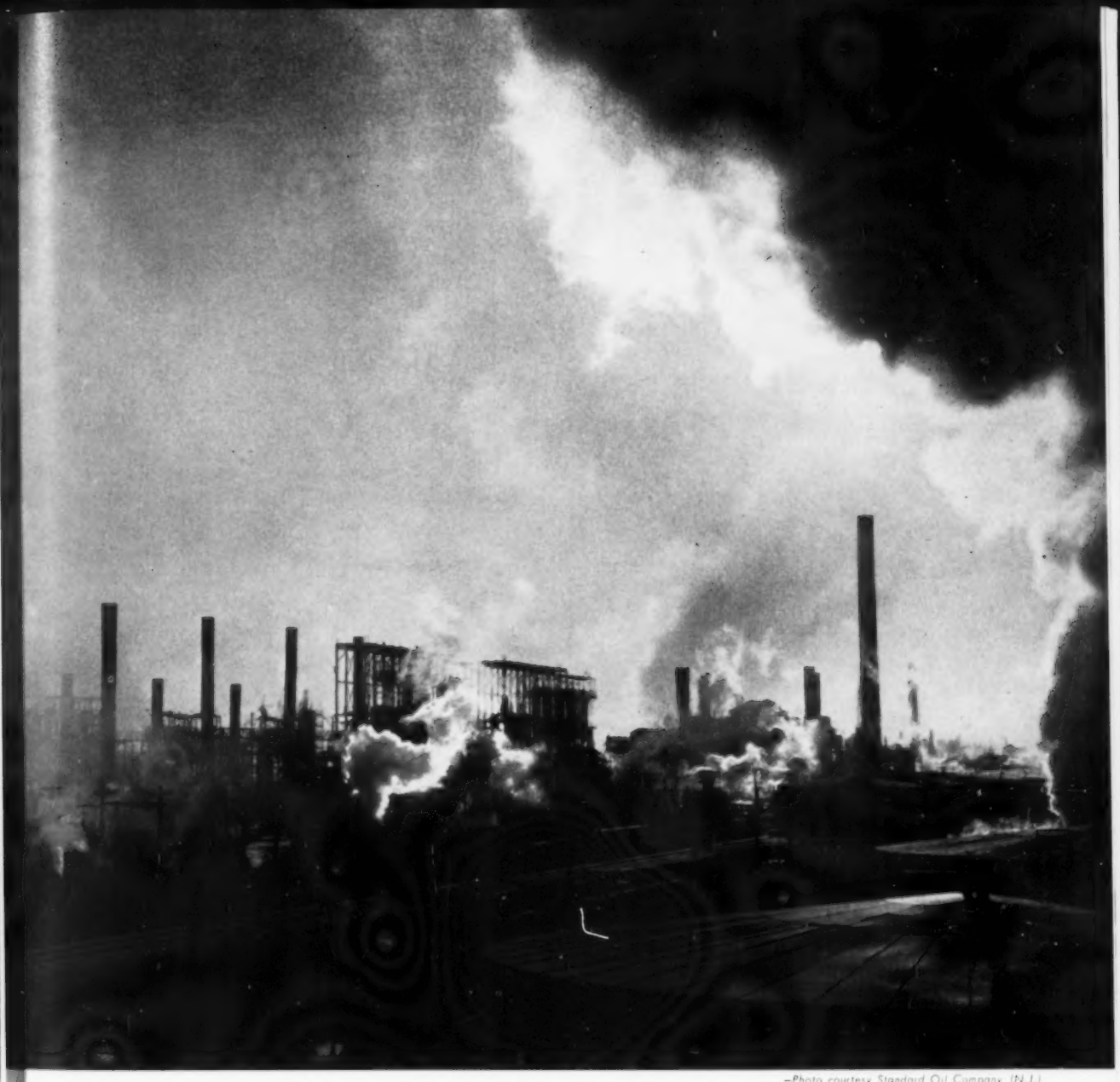
And, as a "bonus" feature Ultralite offers greater heat savings because of its low K and less joints.

If you are now specifying blocks or batt insulation for heated equipment with troweled finishes or sprayed-on weatherproofing, it will pay you to investigate the advantages of an Ultralite-insulated job—completely and permanently weatherproofed with metal. Write to G-B for detailed specifications.

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

266 W. 12th St., Kansas City, Mo.

Thermal and acoustical glass fiber insulations • Pipe coverings and fittings • Molded glass fiber pipe insulation



—Photo courtesy Standard Oil Company (N.J.)

How soon will you be forced to recover stack BTUs?

The constant rise in cost of fuels means simply this: it is becoming more and more uneconomical to dissipate so much of your fuel up the stack. Particularly, since so much of it – nearly one third – can be put *back to work.*

For with modern process equipment, which includes a Ljungstrom Air Preheater, you can save as much as 30% of the fuel burned! That's a *saving of 1½ barrels in every five.*

Heat recovery can also be used to generate higher flame temperatures and increase heat-transfer rates. This makes it possible to *raise through-put as much as 25%.*

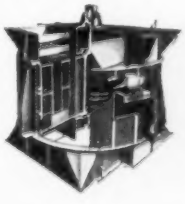
LJUNGSTROMS ARE WRITTEN OFF FAST

Ljungstrom has many other advantages. More complete combustion greatly reduces slagging . . . makes possible use of lower grade fuels . . . helps raise product quality. With these added benefits it's not difficult to see why a Ljungstrom is often paid out in less than a year.

For more complete data on what Ljungstrom Air Preheater can do to help you save on production costs . . . and for an analysis of the heat recovery benefits obtainable in fuel burning equipment – call or write the Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

... to buy new plants for industries all over the world

IT came from companies in 35 foreign countries—and from firms like yours throughout America. It represents more than a billion dollars in plant investment entrusted to McKee for engineering, construction and related services.

There are sound reasons why world-wide industry comes to McKee when it goes shopping for new plants. First, of course, is McKee's demonstrated ability to do the job. Other factors are McKee's 50 years of experience, international scope, large organization of top-grade engineering talent and an unmatched fund of specialized technical knowledge. But the most important reason is ***McKee builds plants that earn profits.***

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ENGINEERING & CONSTRUCTION Services

Arthur G. McKee & Company • Engineers and Contractors
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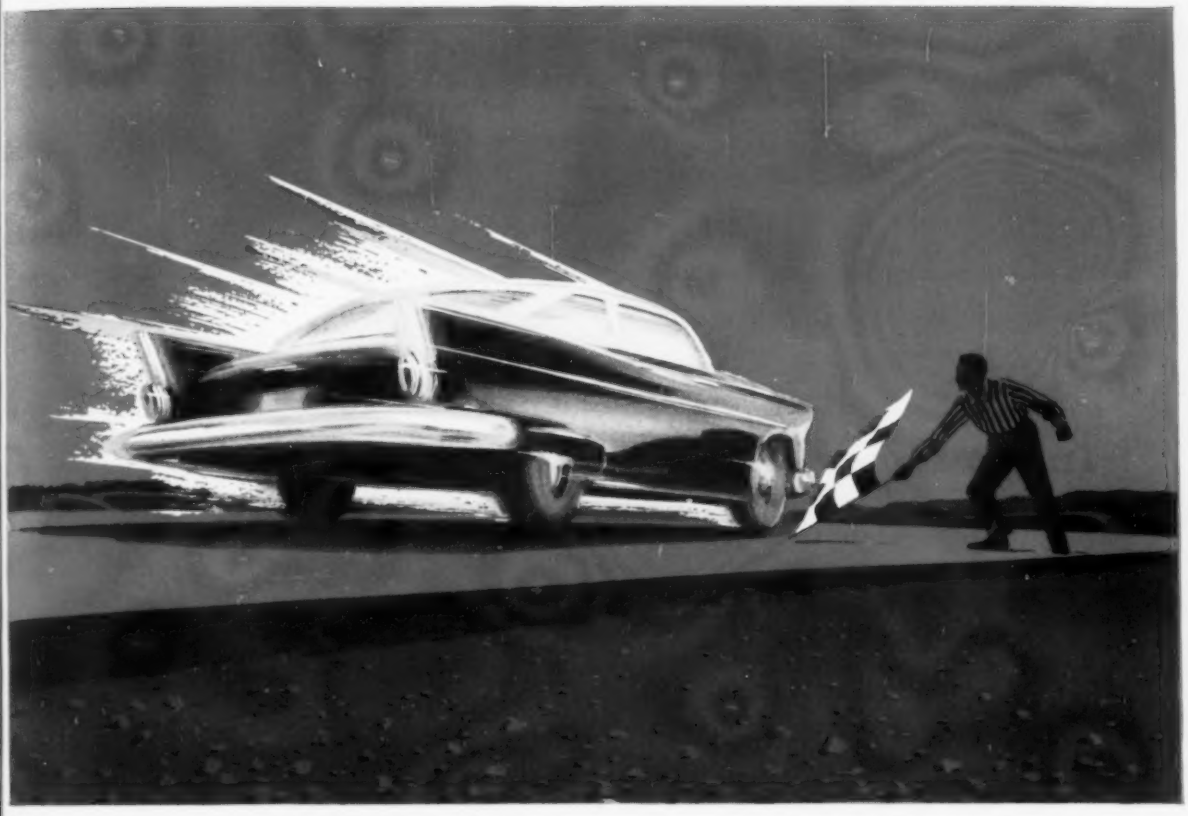
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto



For those new, higher compression engines...

a new Catforming catalyst

The trend to higher compression engines is here to stay. And wide-awake refiners have to produce fuels to suit these up-to-the-minute engines.

Atlantic is proud to offer an advanced Catforming catalyst designed to economically produce higher octane gasolines . . . *and it can be utilized in your present equipment.* For more information, write, wire or call The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

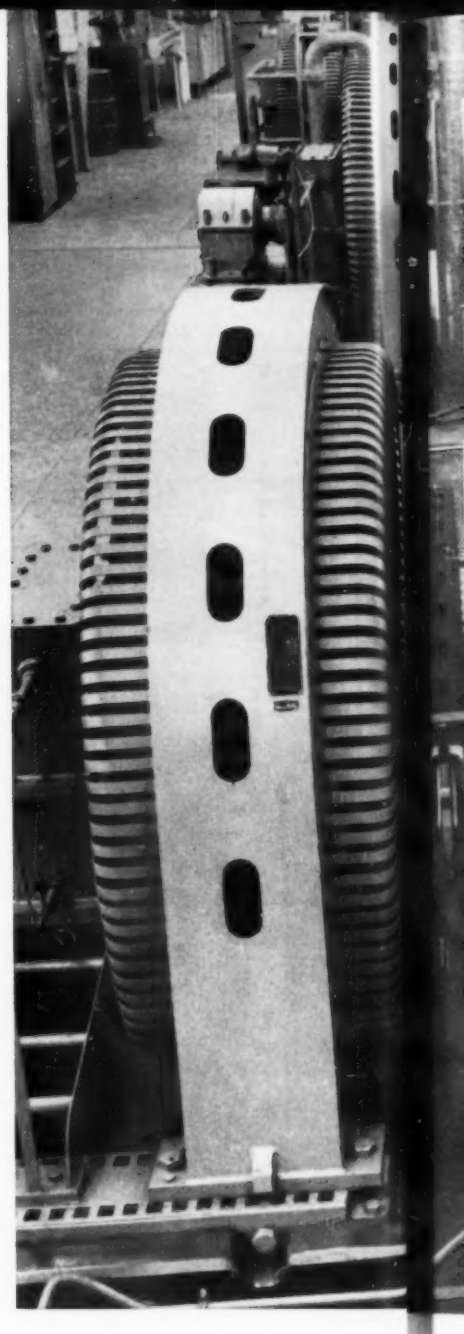
Higher gasoline octanes through Pentafining

You can convert the low-quality n-paraffins (C_5, C_6, C_7) in your gasoline pool to high octanes! Pentafining, the process developed by The Atlantic Refining Company, makes it possible. For full particulars, write today to The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

It's the CATALYST that counts

ATLANTIC

 (To obtain more data on advertised products see page 222)



Cooper-Bessemer 2-cylinder FM's compressing ammonia at the Tuscola plant of U. S. Industrial Chemical.

In Ammonia Service for U.S.I....

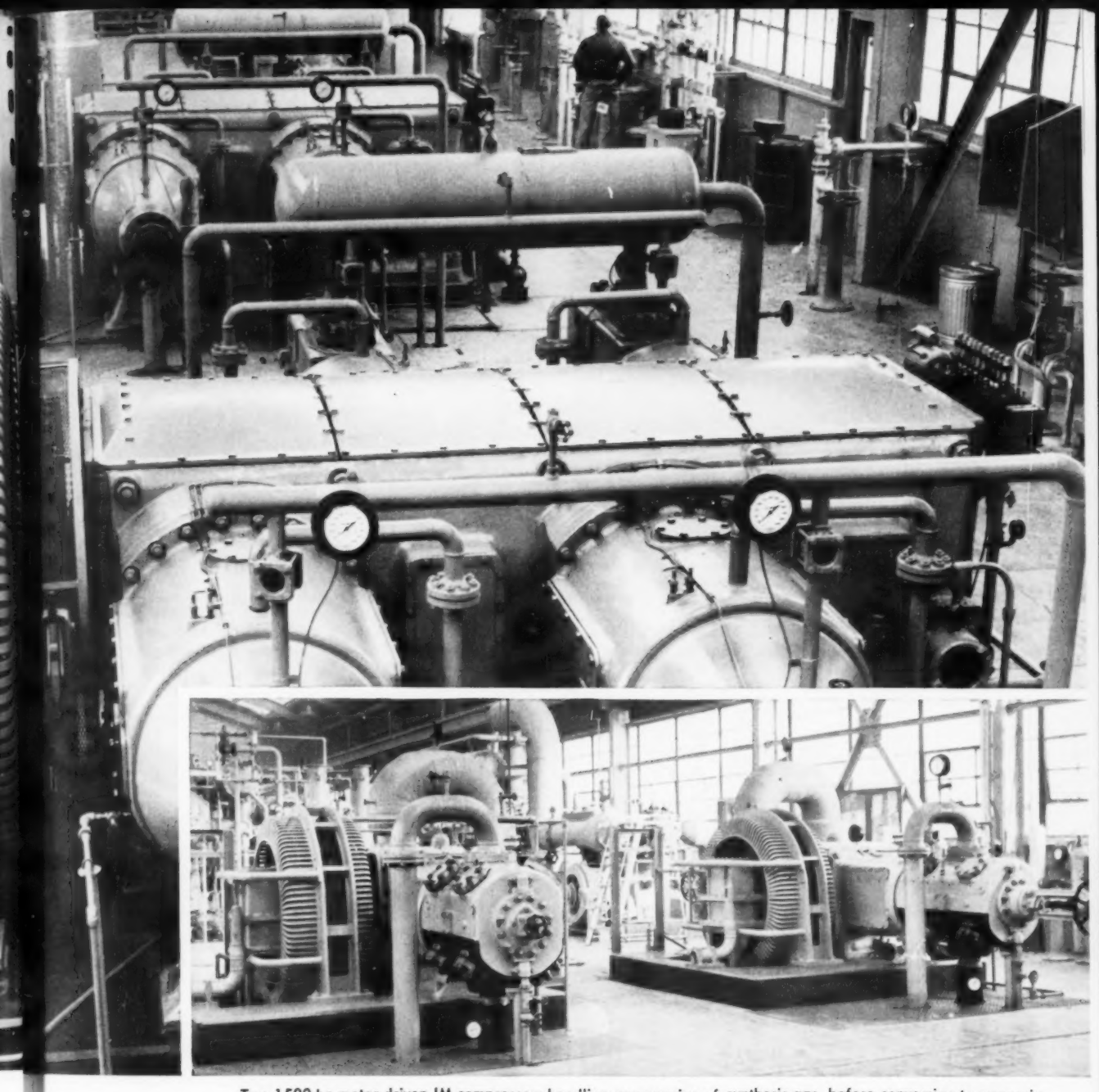
high efficiency Cooper-Bessemer Compressors

This installation at the Tuscola, Illinois plant of U. S. Industrial Chemical Co., a division of National Distillers and Chemical Corp., is typical of the many processing plants using reliable Cooper-Bessemer compressors.

Here, two 4-cylinder JM compressors, each rated 1500 hp, handle compression of synthesis gas; and two 2-cylinder FM compressors, each rated 300 hp, handle the compression of ammonia.

These modern, natural force balance Cooper-Bessemers retain the long-life qualities of much larger slow speed units. The M-Line is exceptionally compact without sacrificing accessibility or ruggedness. They conserve valuable space, reduce over-all installation time, and require less investment in foundations and piping.

Available from 200 to 6000 horsepower, each M-Line compressor unit is engineered to meet specific requirements with extreme efficiency and at the lowest possible cost. The nearest Cooper - Bessemer office will gladly furnish detailed information.



Two 1500 hp motor-driven JM compressors handling compression of synthesis gas, before conversion to ammonia.

Cooper/Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE OR MOTOR DRIVEN

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SUBSIDIARIES: COOPER-BESSEMER OF CANADA, LTD. . . . Edmonton • Calgary • Toronto • Halifax
COOPER-BESSEMER INTERNATIONAL CORPORATION . . . New York • Caracas • Mexico City

J. G. ZIEGLER, Pacific Coast Sales Engineer, a member of the Taylor Team of Instrumentation Scientists, is known internationally in his field. Together, the well-known team of Ziegler and Nichols have collaborated on such published papers as "Optimum Setting for Automatic Controllers," "Industrial Process Control," "Dynamic Accuracy in Temperature Measurement," "Valve Characteristics and Process Control," and many others.

N. B. NICHOLS, Chief Engineer, Taylor Instrument Companies, also has an international reputation as an instrumentation scientist. He was called to MIT during the war to work in the servomechanisms laboratory and later as group leader of the fire control division of the radiation laboratory. He edited a book on servomechanisms, and along with John Ziegler has authored a number of papers on the science of process control.

Bring your problems to these top

GEORGE E. HOWARD, Manager of the important Application Engineering Department of Taylor Instrument Companies, has had over 20 years experience in the design and application of engineered control systems, specializing in the Chemical, Petroleum and Textile Industries. During World War II Mr. Howard trained Government personnel on instrument operation and maintenance at the Government's Oak Ridge Atomic Energy Plant where Taylor was the prime contractor on instrumentation.

RICHARD N. POND, Vice President of the Instrument Society of America and a member of the Executive Board, has served the society in a variety of capacities since he first became active in the St. Louis chapter in 1946. He was secretary, and later chairman, of the committee on Instrumentation for Production Processing. He is a Divisional Sales Manager for his company, specializing in Oil Refining, Petrochemicals, Brewing, Power, Rubber and Plastics.

(To obtain more data on advertised products see page 222)

WE'RE FIELDING our first team at the ISA Show in Cleveland. There will be 27 top Taylormen there—the 4 shown and 23 listed below. We're proud of the ability and experience of this team.

They'll be there—with headquarters at Booth 949-955—to put their skills to work on your own specific instrumentation problems. These men, drawn from our application engineering and sales departments, take to the show broad backgrounds of successful experience in the solution of instrumentation problems throughout the processing industries. They will be there only because you are going, too—so, why not stop by and put them to work on your plant's problems?

These men are typical of the world-wide Taylor sales and engineering organization that stands ready to help you with your instrumentation problems. Taylor Instrument Companies, Rochester 1, N.Y., and Toronto, Canada.

Taylormen at the ISA Show!

J. E. Barber
G. F. Barnum
E. M. Barr
W. J. Berk
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C. S. Conner
D. D. Decker
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A. J. Fleig
L. L. Forward
F. C. Fuzzard
P. Gilman
W. C. Gray
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G. E. Heller
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R. F. Maurer
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INSTRUMENT SOCIETY OF AMERICA

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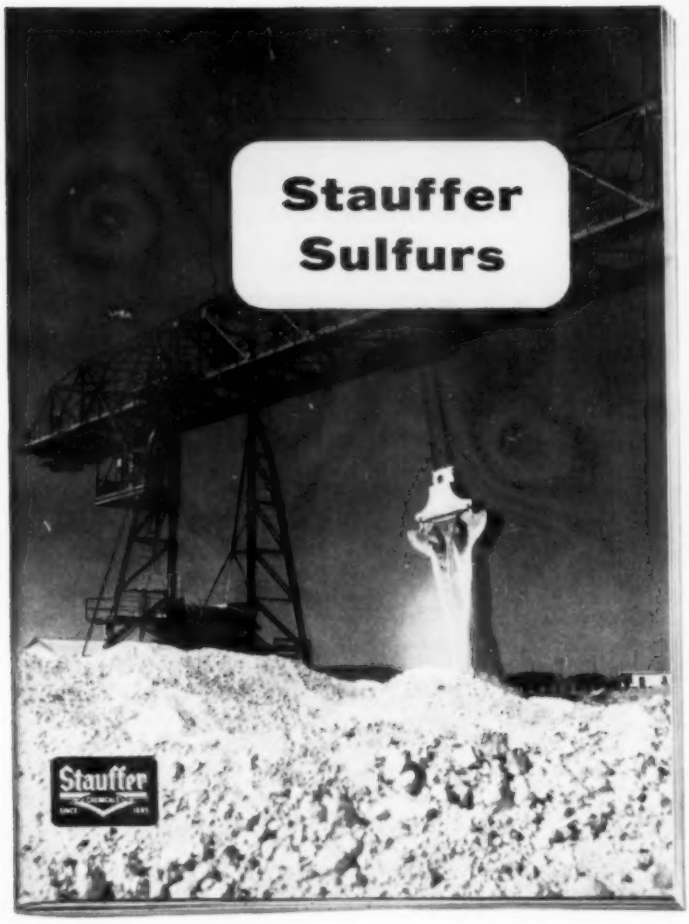
MEAN
ACCURACY FIRST

VISION · INGENUITY · DEPENDABILITY

NOW READY...
THE NEWEST BOOK
ON THE OLDEST CHEMICAL



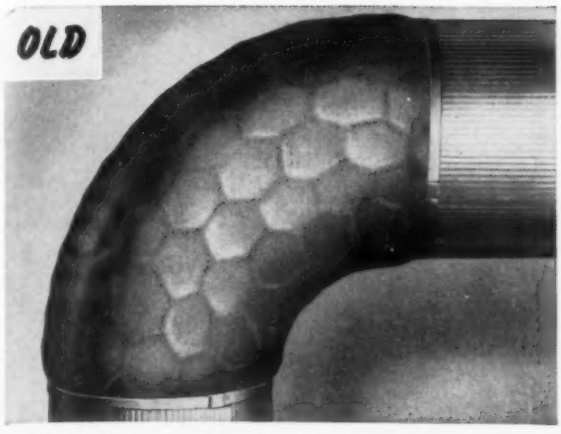
Stauffer Chemical Company — largest user and largest marketer of processed Sulfurs — has prepared a new, authoritative treatise and catalog on Sulfur. The history, preparation and uses, with a detailed description of Stauffer Sulfurs are included in a 52-page brochure with many illustrations and useful tables.

COPIES ON REQUEST; PLEASE WRITE ON YOUR LETTERHEAD.

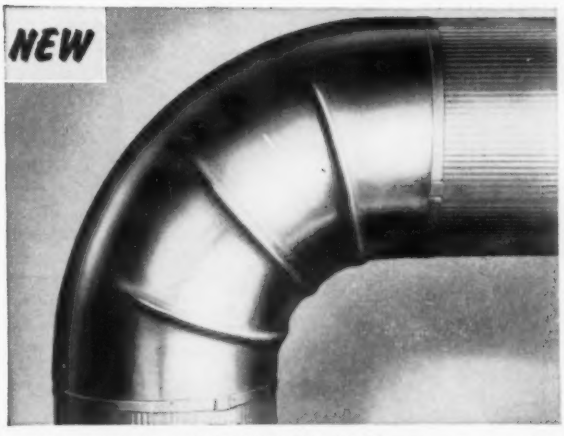
Stauffer CHEMICALS SINCE 1885

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N. Y.
Prudential Plaza, Chicago 1, Ill.
636 California Street, San Francisco 8, Calif.



UGLY, COSTLY CHICKEN WIRE AND MASTIC elbow coverings like this are now obsolete. New Childers Aluminum Ell-Jacs end the need for slow, costly hand-made "patches". Childers Ell-Jacs keep their new look, never need expensive periodic painting or maintenance.



NEW CHILDERS ALUMINUM ELL-JACS now make possible neat, weather-tight aluminum protection from one end to the other of your insulated lines. Childers Ell-Jacs are precision formed for long-radius 90° and 45° ells and have factory-applied moisture barrier.

Childers Announces New Aluminum Elbow Jacketing For Insulated Lines

Revolutionary new Childers Ell-Jacs go on fast and easy . . . fit perfectly . . . cut installation costs . . . never need painting . . . and, used with Childers Jacketing, give your insulated lines that well-dressed look from end to end.

Now, aluminum elbows are made in a wide range of sizes by America's leading manufacturer of aluminum jacketing. Childers Aluminum Ell-Jacs are available for quick, easy application to protect costly elbow insulation.

Childers Ell-Jacs, together with Childers Jacketing, enable you to install maintenance-free aluminum over every square foot of your valuable insulation. You protect *all* of your insulation investment at lowest cost. You get the bonus of a better looking plant and easier housekeeping. Aluminum *keeps* its new look, needs no expensive periodic painting.

Positive weather-proofing, too, is assured by exclusive Childers Lap-Seal (Patents Pending). Factory-attached moisture barrier prevents harm to the underneath side of the aluminum.

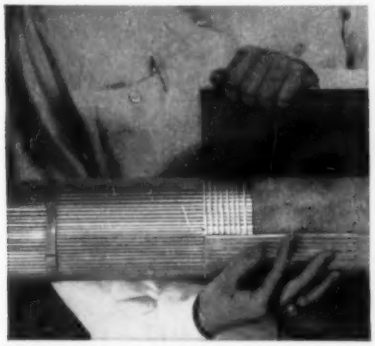
First cost is less for Childers Jacketing than for any other permanent type weatherproofing—even less than some temporary coverings.

You also get greater strength and greater protection because Childers Jacketing is cross-crimped.

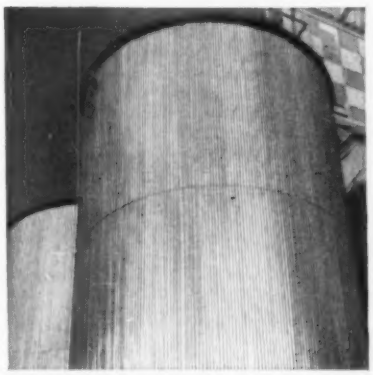
It's easy to install Childers Jacketing. All you need are pliers and screwdriver, plus inexpensive strapping. Two men can do the job. Jacketing can be removed for inspection of the lines, then reapplied without waste.

Why not benefit from Childers world-wide experience when you buy insulation for your lines, towers, vessels, and tanks? More than 2,000 petroleum refining, petro-chemical, and chemical plants will endorse your decision. Childers Engineering Representatives, located in 27 major industrial centers, give professional advice on insulation jacketing.

For a free sample of Childers Aluminum Weather-Proof Jacketing, with engineering data on how to safeguard your insulation, write Childers Manufacturing Company, Dept. PP-11, P. O. Box 7467, Houston 8, Texas.

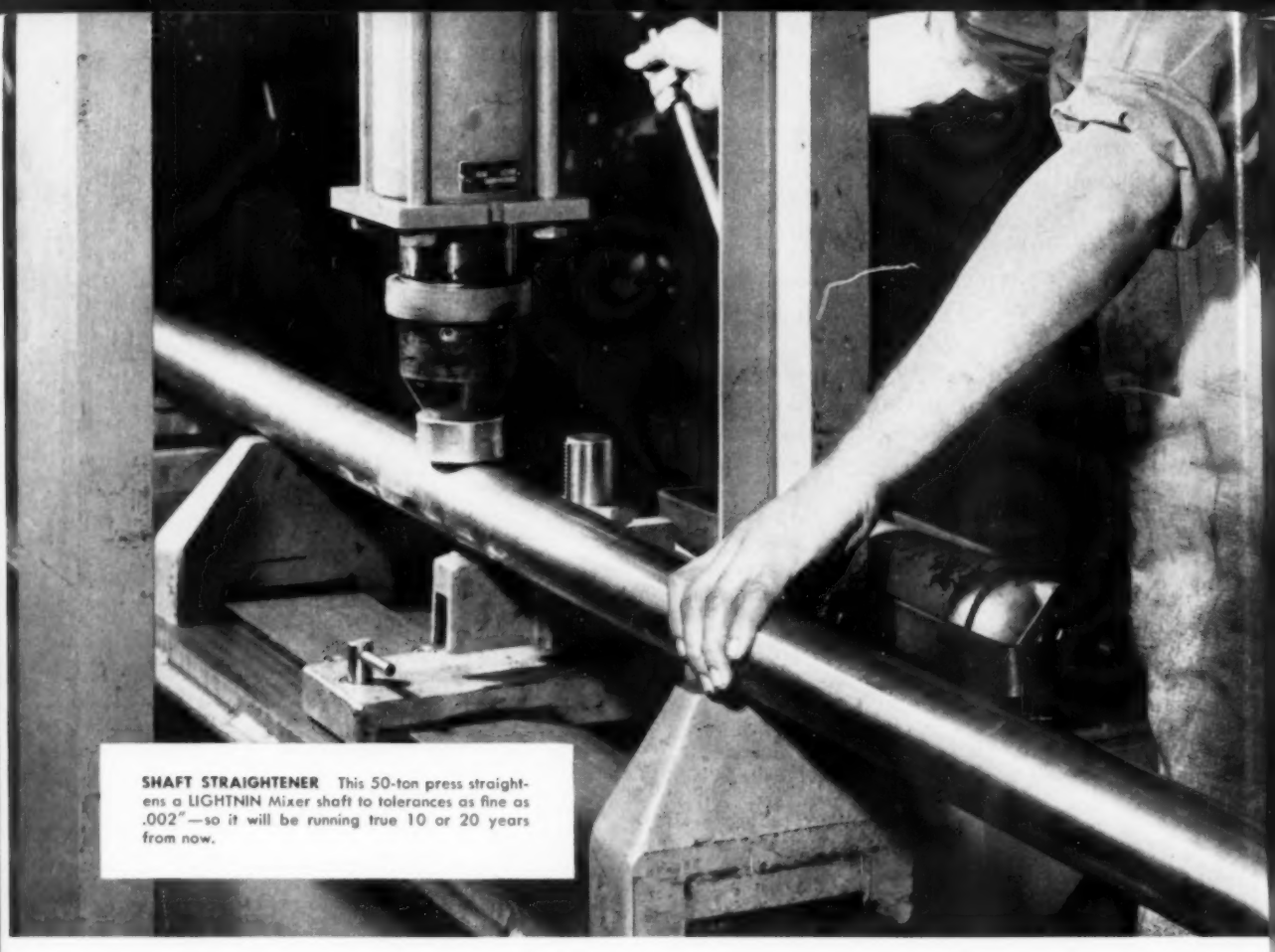


EXCLUSIVE LAP-SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of the jacketing, providing automatic measure of the 2" circumferential lap. Proper lap is assured without waste. Labor is saved. Where desired, a positive weather seal is easily made with Lap-Seal and a mastic.



DEEP CORRUGATED Childers Jacketing in 1¼" and 2½" corrugations is recommended for permanent protection and improved appearance of insulated towers, vessels, tanks. Deep Corrugated Jacketing with factory-attached moisture barrier is another product available only from Childers.

See Childers' ad in Sweet's Industrial Construction File, Chemical Engineering Catalog and Refinery Catalog.



SHAFT STRAIGHTENER This 50-ton press straightens a LIGHTNIN Mixer shaft to tolerances as fine as .002"—so it will be running true 10 or 20 years from now.

How to prevent **shaft failure** *when you mix fluids mechanically*

An out-of-line shaft on a mechanical mixer can be bad for your process, in more ways than one.

A shaft that bends or breaks may not cost much to replace—but can cost plenty in downtime. Even a slight misalignment in the shaft can set up stresses leading to shaft breakdown. And an off-true shaft makes it impossible to operate a stuffing box or rotary mechanical seal efficiently.

Importance of straightness

That's why every LIGHTNIN Mixer shaft must pass the test shown above, so it will run true when it gets into your tank.

The *shaft straightness* you get when you specify LIGHTNIN Mixers means several important economies.

For example, you can use two different metals in the same two-piece rigidly coupled shaft: corrosion-resistant alloy in the tank, plain steel above the splash line. This two-piece construction has many other advantages; it's possible only because of the most careful straightening and machining.

Know what shaft will do

You can draw on a wealth of cost-cutting shaft application data, too, when you mix with LIGHTNINS. What's the most economical shaft diameter that lets you skip the upkeep of a submerged steady bearing in the tank bottom? How can you avoid paying for excessive "safety factor" in an overhung shaft that must run smoothly during draw-off? We can give you the right answers, quickly and without guessing—based on thousands of test runs in a uniquely equipped fluid mixing laboratory.

This extra care in shaft design and application is just one example of a *way of thinking* that goes to work for you when you unload a fluid mixing problem on a specialist engineering firm like MIXCO.

It's one more reason why you get surer, more efficient fluid mixing—better process results — when you specify LIGHTNIN Mixers.

For quick, competent help on fluid mixing operation, call in your LIGHTNIN representative. He's listed in Chemical Engineering Catalog. Or write us direct.

Lightnin® Mixers

MIXCO fluid mixing specialists

SHAFT DEFLECTION TEST records the play of fluid forces on LIGHTNIN Mixer impeller and shaft. Data permit accurate prediction of shaft critical speeds, and most economical shaft selection for a given mixing job.

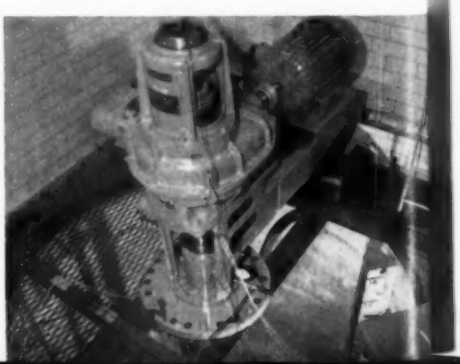
FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering; propeller types: ¼ to 3 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-109 Condensed catalog showing all types
- ☐ B-111 Quick-change rotary mechanical seals for pressure and vacuum mixing
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 131-J Mt. Read Blvd., Rochester 11, N. Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.



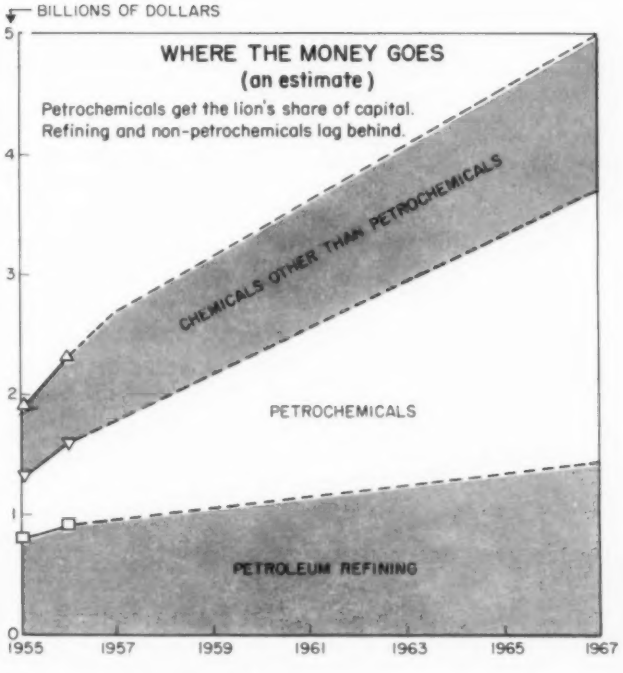
Petroleum Processing
September, 1957

Petrochemicals Race Ahead

. . . to overtake all other chemicals

- 1957 petrochemical output 9 times that of 1940
- Total petrochemical industry assets now $4.5 billion
- Petrochemicals are 25% of total chemical production
- In 10 years petrochemicals will be 50% of all chemicals
- Petrochemical growth opportunities are enormous and growing

By HENRY G. McGRATH, Associate Manager
New Business Development Dept., The M. W. Kellogg Co.



THE petrochemical industry is an integral part of the oil industry. Petrochemicals from natural gas and petroleum serve as raw materials for nearly 3000 chemicals, and new products are coming in at a rate of 400 per year.

This great industry had its start in the 1920's, and today is a large portion of the chemical industry. The chemical industry itself is now our fourth largest manufacturing industry, having expanded its output (at constant dollars) more than three times since 1939. An idea of the extent to which synthetics have taken over is found in the fact that resins and plastics are more than 95% synthetic, and new rubber is over 60% synthetic.

This year, total petrochemical production will exceed a volume of 35 billion lb. Last year, petrochemicals comprised 25% of the total U.S. chemical production of about 143 billion lb. These figures, and extrapolations up through 1967, are shown in Table. 1.

Interestingly enough, the dollar

Fig. 1—Rate of growth of all industry lags oil and allied products segment

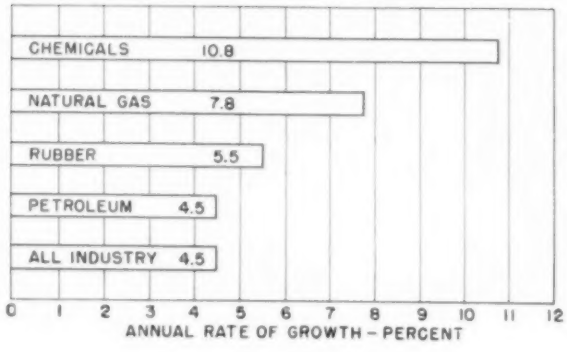


Fig. 2—Petrochemical sales are catching up but have long way to go

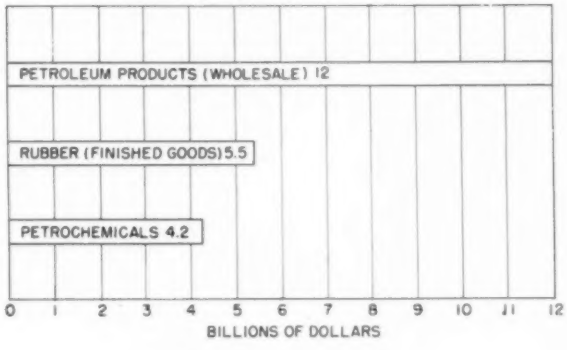


Fig. 3—Chemicals enjoy favorable net income per dollar of net worth

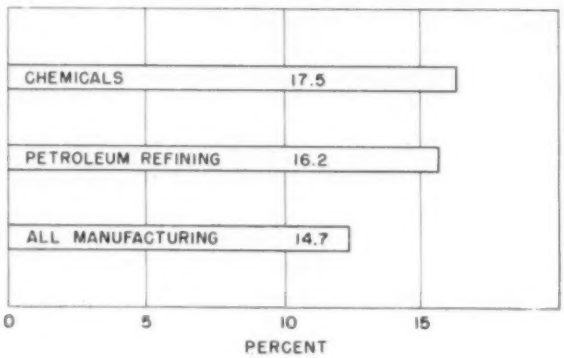
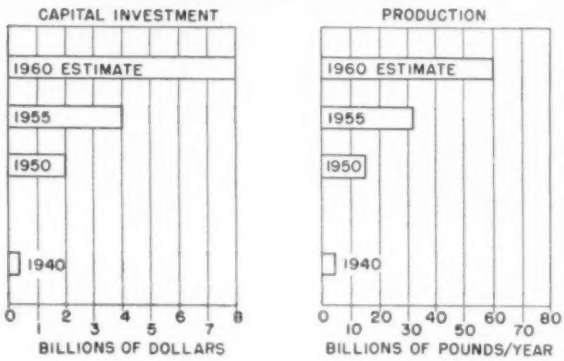


Fig. 4—Production keeps pace with petrochemical investment



value of petrochemicals last year was about 55% of the value of total chemicals. These values, also with estimated dollars values through 1967, are given in Table 2.

Capital investment of the petrochemical industry in manufacturing facilities is presently about $4.5 billion, an increase of $0.7 billion in the past year. This investment is believed to be 55-60% of the assets of the entire chemical industry. Because the petrochemical industry has been doubling every five years, it is expected that the capital investment in 1960 will be $8 billion. The illustration at the head of this section shows estimated capital investments for refining, petrochemicals and other chemicals for the period 1955-1967.

Petrochemicals may be divided broadly into three classes; aliphatics, aromatics and inorganics. In 1960, the estimated production of the different classes of compounds is listed as follows:

Aliphatics	40 billion lb/yr
Aromatics	5 billion lb/yr
Inorganics	15 billion lb/yr

Table 1—Past and future production for petrochemicals and all chemicals

Year	Petrochemicals Output, billion lb	All Chemicals Output, billion lb	Petrochemicals % of all chemicals
1953	25.3	114.3	22
1954	26.5	114.6	23
1955	32	134.8	24
1956	35	143	25
1957 (est'd)	40	156	26
1958 (est'd)	46	165	28
1960 (est'd)	60	190	33
1965 (est'd)	115	265	44
1967 (est'd)	137	295	46

Table 2—Dollar value of past and future production of petrochemicals and all chemicals

Year	Petrochemicals Value, billion $	All Chemicals Value, billion $	Petrochemicals % of all chemicals
1953	3.2	6.1	52.7
1954	3.2	6.0	52.5
1955	3.7	7.2	51.5
1956	4.2	7.8	55
1957 (est'd)	4.6	8.4	55
1958 (est'd)	5.2	9.2	56
1960 (est'd)	6.4	10.9	59
1965 (est'd)	11.8	17.2	69
1967 (est'd)	14.0	19.7	71

About a year ago, the average price per pound was 15¢ for aliphatics, 19¢ for aromatics, and 2.5¢ for inorganics. In 1955, petrochemical sales amounted to $3.7 billion and in 1956 they were $4.2 billion.

For each of the past six years, the capital expenditure in chemicals and allied products has exceeded $1 billion. Construction expenditures in 1956 were nearly $1.4 billion, as shown in Table 3. Capital expenditures for petrochemicals are expected to increase to more than $1 billion annually in 1960, and to expand further to almost $2.5 billion annually by 1967. Corresponding figures for total chemicals and allied products for 1960 are $2 billion and for 1967 between $3.4 billion and $4.1 billion.

In the leading illustration, the estimated capital investments for petroleum refining, petrochemical plants, and other chemical plants are shown for the next 10 years. In 1960, it is expected that the annual rate of capital spending for new equipment and plants in petroleum refining will be about $1.1 billion, increasing to $1.4-1.5 billion annually by 1967.

Today, capital expenditures for new petrochemical plants are about equivalent to those for oil refining. However, the annual rate of spending for new plants in the field of petrochemicals in the next 10 years is expected to far exceed that for oil refining.

Capital expenditures for chemical plants outside the petrochemical field in 1960 are estimated at $1 billion, and in 1967 at nearly $1.5 billion for this purpose.

Diversity of ownership

Petrochemicals are broadly defined as those chemicals derived from natural gas and petroleum sources (see "What is a petrochemical?" on p. 106 of this issue for further definition of petrochemicals). For many years, both oil and chemical companies have participated in the exploitation of petrochemicals. In recent years, diverse companies including shipping, farm equipment, rubber manufacturing and gas pipeline firms have all entered the field.

Examination of some of the historical growth figures and profit margins, and the anticipated growth patterns, makes it easy to understand the great and continuing activity in this field. It is difficult to separate statistical information on the petrochemical industry from data on the chemical industry as a whole, so the following figures compare the entire chemical industry with the natural gas, petroleum, rubber, and all industry to give a picture of the size and scope of this growing field.

The relative rate of growth of the selected industries is shown in Fig. 1. The chemical industry's growth of 10.8%/yr surpasses that of the other major industries shown. By comparison, the annual growth rate from 1931 to 1956 was 7.8% for natural gas, 5.5% for rubber products, 4.5% for petroleum, and 4.5% for all industries. In these cases, growth is measured on a production basis.

Annual sales for the petrochemical, rubber and petroleum industries are shown in Fig. 2. Last year, petrochemical sales were $4.2 billion, rubber (finished goods) $5.5 billion, and $12 billion for petroleum products. The last figure is based on wholesale prices before state and federal taxes, which are both substantial.

The net incomes per dollar of net worth for the chemical and allied products, petroleum, and all manufacturing operations are given in Fig. 3. These figures are an average for the period 1947-1951. The return for chemicals and allied products was highest at 17.5%, petroleum refining was 16.2% and all manufacturing was 14.7%.

The expected growth rate, along with past and present growth, for the petrochemical portion of the chemical industry is shown in Fig. 4. Capital investment and production have increased better than fourfold from 1940 to 1950. From 1950 to 1955 the industry doubled. This rate of growth is expected to continue from 1955 to 1960. In other words, the capital investment for petrochemicals in 1960 may be $8 billion.

The preceding charts show the chemical industry, particularly the petrochemical industry, to be both fast growing and profitable. It is characterized, however, by high investment per unit of production, and by rapid technological obsolescence.

Fuel petrochemicals

Even though fuels do not come under the accepted definition of petrochemicals, no discussion of petrochemicals would be complete without recognition of the gradual change that has been taking place in oil refining over the years. Petroleum refining is becoming more and more a series of chemical processing operations. Today's premium gasoline is a clear cut example of this change in refining practice.

Premium gasoline has become the world's greatest outlet for petrochemicals. Years ago, this product was put together awkwardly, primarily by brute strength. Today, it is becoming more and more a matter of blending specific chemical compounds for a superior quality product.

The octane race in the petroleum industry, which has been in progress for some years, will continue for many years to come. The average octane number of premium gasoline today, country-wide, is 98.2. Several refiners are now marketing a fuel of better than 100 octane. The greatest single factor in this rise in octane in recent years is the widespread use of catalytic reforming processes. About 1,250,000 barrels of naphtha are being reformed every day in this country.

Aromatic compounds furnish tremendous help to the refiner in con-

Table 3—Capital expenditures for petrochemicals and all chemicals

Year	Petrochemicals Expend., billion $	Total Chemicals and Allied Prods., billion $
1955	0.5	1.1
1956	0.7	1.4
1957 (est'd)	0.9	1.8
1958 (est'd)	1.0	1.9
1960 (est'd)	1.1	2.0
1965 (est'd)	2.0	3-3.5
1967 (est'd)	2.2	3.4-3.8

Table 4—Clear research octanes of aromatics

Benzene	99
Toluene	124
o-Xylene	120
m-Xylene	145
p-Xylene	146
Ethylbenzene	124

Table 5—Availability of major petrochemicals

(from President's Materials Policy Commission report of June, 1952)

	Billions of lb	
Paraffins	**1955**	**1960**
Methane	119	129
Ethane	27	28
Propane	27	30
Butane	26	31
Olefins		
Ethylene	24	27
Propylene	29	32
n- & iso-Butylene	31	36
Aromatics		
Benzene	9	12
Toluene	18	23
C_8's (xylenes & ethylbenzene)	23	29

What is a petrochemical?

pet'ro·chem'i·cal, n. A chemical compound or element recovered from petroleum or natural gas or derived in whole or in part from petroleum or natural gas hydrocarbons, and intended for chemical markets. (PETROLEUM PROCESSING, April 1952, p. 490.)

"Examples of petrochemicals are ammonia made from natural gas, and synthetic rubber, a mixture of hydrocarbon polymers. Carbon black, essentially pure carbon, is a petrochemical.

The major petrochemicals are ammonia, synthetic rubber, carbon black, ethylene, propylene, butylene, butadiene for rubber, acetylene, benzene, toluene, styrene, polyethylene, phenol, formaldehyde, acetaldehyde, methyl alcohol, ethyl alcohol, isopropyl alcohol, butyl alcohols, ethylene oxide, ethylene glycol, acrylonitrile, acetic acid, acetic anhydride and acetone. The minor products are numbered by the thousands." ("Petroleum and Natural Gas," Bulletin 556, Bureau of Mines, p. 8.)

tinually improving the performance of premium gasoline. Aromatics are without a doubt the biggest petrochemical in this service. Table 4 shows the clear research octane numbers of octanes with six, seven and eight carbon atoms per molecule. The one with lowest octane is seen to be benzene, with an octane of only 99, and the two highest octanes are for meta and para-xylene at 145 and 146 octane, respectively.

Alkylate production (certainly a petrochemical process) is currently in the vicinity of 250,000-300,000 b/d. This process combines isobutane with olefins to make high octane fractions suitable for blending with other gasoline components for aviation or motor fuels. In operation many years, alkylation uses either sulfuric acid or hydrofluoric acid as the catalyst. One of the constituents of alkylate is 2,2,4-trimethylpentane, which by definition is 100 octane.

Major petrochemicals

The President's Materials Policy Commission report of June, 1952, estimated hydrocarbon intermediates available for chemical conversion on the basis of an estimated production of 2.5 billion bbl of oil in 1955 and 3.0 billion in 1960. Actual U.S. production was 2.73 billion bbl in 1955. The report estimated natural gas production at 9.2 trillion cubic feet in 1955 and 11.4 trillion in 1960. Table 5 shows the overall picture expressed as billions of lb.

Hydrogen and carbon monoxide are two important petrochemicals made from methane. These two chemicals are vital in a number of syntheses, including ammonia, methanol, Oxo alcohols, the Fischer-Tropsch synthesis, and countless reduction (hydrogenation) processes.

Byproduct hydrogen, such as is obtained from a petroleum refining process, was first commercialized 16 years ago, and has had a profound effect on hydrogenation processes.

All of the aforementioned processes fall in the hydrogenation category.

The more than 700 million cu ft/d of hydrogen produced from Hydroforming or catalytic reforming represents a rich raw material supply. If a little work is done on it, the byproduct hydrogen jumps to a value of as much as 40-50¢ per thousand cubic feet, considerably more than its worth as a fuel. This product is, therefore, worth many millions of dollars per year to the refiner.

Synthetic ammonia, many years ago, could lay no claim to being a petrochemical. Today, it is surely one. A combination of several factors has revolutionized the fertilizer industry—particularly the ammonia segment.

Two primary facts stand out in any discussion of the rapidly expanding fertilizer industry. One is the annual increase in population, and the other is that relatively little additional land can be brought under cultivation. A growing awareness that greater use of fertilizer was the best way to increase and maintain crop production, as well as decrease the cost of production, has been largely responsible for the fertilizer revolution.

Nitrogen consumption has probably tripled in the last 10 years. Early last year, the anhydrous ammonia capacity was 4.1 million tons. This year it is expected to be 4.8 million tons. It has been reported that the most profitable rates of fertilizer application would correspond to 10 times the current total use of the three primary plant nutrients (nitrogen, phosphorus and potassium). The implications of such a volume become apparent immediately.

Most oil companies are using natural gas for ammonia production. An ammonia plant represents a substantial investment. A unit to make 300 t/d, including off-site facilities, etc., might cost as much as $10 million.

Ammonia plants may be converted to the production of methanol, the second-largest-volume product from methane. Production of methanol is now over 1.5 billion lb per year, and is growing. Methanol is used for making formaldehyde, antifreeze, and solvents.

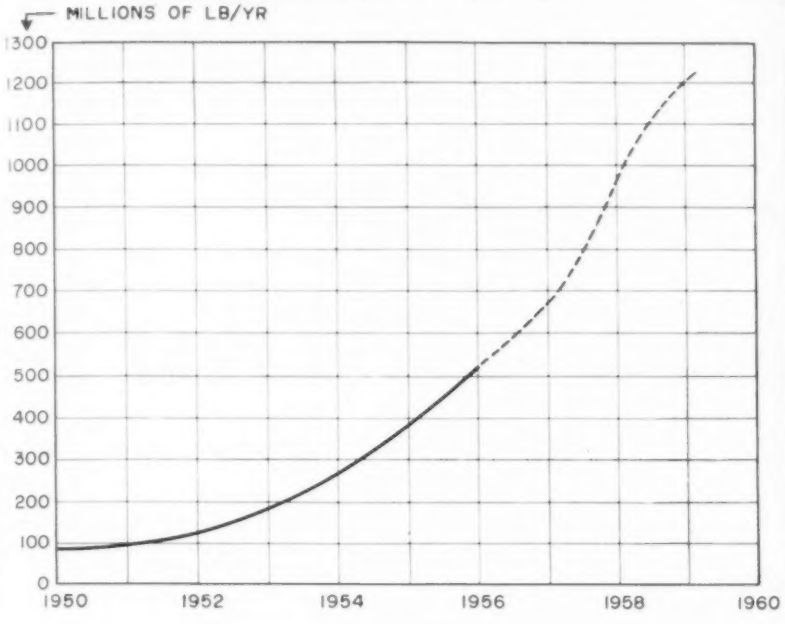
Ethylene follows ammonia (except for those petrochemicals such as alkylate and aromatics, which are largely burned in fuels) as the second highest-tonnage material supplied from petroleum and natural gas. The growth of ethylene as a chemical raw material in the last 10 years has been spectacular. Its present annual consumption is at the rate of 3.5 billion lb per year and is growing rapidly. The list of ethylene derivatives is increasing steadily until it now contributes to nearly twice as many chemicals and chemical intermediates as both propylene and butylene.

The most rapidly growing market for ethylene is in polyethylene plastics. In addition to its well-established use for wire insulation, packaging films, pipes and bottles, it is finding new applications in its low polymer forms as wax substitutes. Production over the past several years, and estimated to 1960, is shown in Fig. 5. Unless some far superior materials are developed, a billion-pound-a-year production rate for polyethylene could be reached befor 1960.

Fischer and Tropsch made one of the most significant contributions in the field of chemistry in the past generation in their discovery of hydrocarbon synthesis. The interaction of hydrogen and carbon monoxide results in an extraordinarily interesting series of chemical reactions.

Among the organic chemicals that can be synthesized from hydrogen and carbon monoxide are paraffins, olefins, aromatics, alcohols, aldehydes, ketones and acids. The most recent development in the synthesis of organic compounds from hydrogen and carbon monoxide has been the application of the powdered catalyst technique. This type of operation has several apparent advantages over the fixed-bed type and is expected to yield organic com-

Fig. 5—U.S. polyethylene capacity rises fast



pounds of high quality in large quantities this year.

Acknowledgment

The writer wishes to express thanks for the help given by K. S. Adams of Phillips Petroleum Co., Jerry McAfee of Gulf Oil Corp., M. E. Spaght of Shell Oil Co., J. K. Roberts of Standard Oil Co. (Ind.), L. C. Kemp, Jr. of The Texas Co., H. L. Malakoff of Petroleum Chemicals, Inc., W. C. Asbury of Esso Research & Engineering Co., and W. F. Bland of PETROLEUM PROCESSING, in the preparation of this article.

Meet the author

Mr. McGrath

Henry G. McGrath is associate manager of the New Business Development Dept. of the M. W. Kellogg Co. He received his B.S. in chemical engineering from Massachusetts Institute of Technology in 1936, and his M.S. in chemical engineering practice from M.I.T. in 1937, after which he joined Kellogg.

For several years he was associate director of Research, and one of the key figures in the company's process development program. He concentrated on aromatics, aviation gasoline, high-octane gasoline, catalysts and the application of the fluid catalyst technique to petroleum and chemical processing. Following this period, he served two years as Administrative Assistant to the Vice President.

In 1954, Mr. McGrath became associate manager of the company's newly formed New Business Development Dept. Today, he integrates the creative thinking of people both in and out of his organization to improve the company's process engineering of petroleum and petrochemical plants. For many years he has been a spokesman for his organization before technical groups in all parts of the world.

Mr. McGrath is the author of many technical papers and symposia on petroleum processing and chemical production. He holds more than 30 U.S. patents in these fields. He has a professional engineer's license in New York State, and is a member of the A.P.I., A.I.Ch.E., A.C.S., and C.M.R.A.

PETROCHEMICALS
1957 REPORT

Good reading ahead

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Petrochemicals' role grown stronger in chemical world

	Output (billions of lb)					Value (billions of $)				
	1955	1956	% Change 1955-56	1957	% Change 1956-57	1955	1956	% Change 1955-56	1957	% Change 1956-57
Aliphatics	20.0	22.5	+12.5	23.52	+4.6	2.77	3.22	+16.2	3.36	+ 4.3
Aromatics	3.2	3.7	+16.0	4.0	+8.0	0.58	0.66	+13.8	0.72	+ 9.1
Inorganics	9.0	9.8	+ 8.9	10.74	+9.6	0.36	0.39	+ 8.3	0.43	+10.2
Total petros.	32.2	36.0	+11.8	38.3	+6.4	3.71	4.27	+15.1	4.51	+ 5.6
All chemicals	134.8	142.3	+ 5.6	151.0	+6.1	7.22	7.82	+ 8.3	8.20	+ 4.8
Petros. as % of all chemicals	24.0%	25.3%	+ 5.4%	25.4%	+0.4%	51.4%	54.7%	+ 6.4%	55.0%	+ 0.5%

NOTE: Product and value data are by Dr. R. L. Bateman, director of product development, Union Carbide Chemicals Co., New York.

Petrochemicals Gain in 1957

. . . but rolling adjustments slow rate

PETROCHEMICAL production in the United States in 1957 will rise to 38.3 billion lb, a 6.4% increase over 1956. This is slightly less than the 11.8% output gain a year ago, and much less than the nearly 21% gain for 1954-1955.

Detailed figures and comparisons are shown in the table above. But note that about one-third of the estimated gain for this year over last is the result of a revision in the accounting procedures used in previous years.

The slower growth this year is partly a result of consolidation of recent rapid expansions. Rolling adjustments in allied industries, such as rubber, also contributed.

High spots that will keep pushing petrochemical manufacture upward in coming years include: 1—expanded production of and uses for polyethylene, 2—an outstanding growth rate for the new polyurethane foams, and 3—new developments in the uses of rubber.

The estimates come from studies of the growth in petrochemicals made by Dr. R. L. Bateman, Union Carbide Chemicals Co., studies he had made yearly since 1947.

Estimated 1957 output of 38.3 billion lb is 25.4% of the anticipated total U.S. output for all chemicals of 151 billion lb This latter figure is a gain of 6.1% over 1956, compared with the 6.4% gain in petrochemicals.

All three classes of petrochemicals will show significant gains this year, Dr. Bateman believes.

Inorganics replace aromatics this year as the fastest growth segment—9.6% from 1956 to 1957 compared with 8.9% from 1955 to 1956. Aromatics, contributing the smallest volume to petrochemical production in 1957 (only 4 billion lb) will gain about 8% over 1956, which in turn had risen 16% above 1955. The greatest drop in growth rate is shown by the aliphatics, which are estimated to show only a 4.6% gain from 1956 to 1957.

The value of total petrochemical output for 1957 is estimated at $4.51 billion, a 5.6% gain over 1956. The increased petrochemical share of the value of all chemicals is shown vividly by the growth from 51.4% in 1955 to 54.7% in 1956, and the estimated 55% this year—$4.51 billion out of $8.2 billion.

Rates of gain in product values correspond closely to those for product outputs. Inorganics lead with a 10.2% gain over 1956 values. Next in line are the aromatics with a 9.1% increase over 1956.

Aliphatics, although registering the smallest gain in product value (only 4.3% from 1956 to 1957), remain the largest slice of the total petrochemical product value figure.

In the overall petrochemicals picture, synthetic rubbers are hot in new developments—but most of the new large volume markets are 1-2 years away.

Polyethylenes, with an estimated 1957 production increase of 160 million lb/yr (up 700 million lb/yr), have found many new uses in the packaging field. Some are entirely new—in fields where no packaging was used before.

Polyurethanes are another product with an outstanding growth rate. Though current production is small, large expansions are coming fast. One factor pushing this growth is the development and application of processes using polyether intermediates in place of the previously used polyesters, which simplifies production and lowers costs.

Meet the authority

Dr. Bateman

Dr. Robert L. Bateman's reports on current petrochemical production in the U.S., and on the growth trend of this relatively young, but growing industry, have been an exclusive feature of PETROLEUM PROCESSING'S Petrochemical Issue for the four past years.

Dr. Bateman, director of product development, Union Carbide Chemicals Co., New York, started making these studies in 1947, when it was known as the "synthetic aliphatic industry." He has projected them annually since.

A native of New Jersey, Dr. Bateman studied at Ursinus College and received his M.S. and Ph.D. from the University of Pennsylvania, the latter in 1935. He joined the Organic Synthesis Fellowship of Carbide and Carbon Chemical Co. (now Union Carbide Chemicals Co.) at Mellon Institute, Pittsburgh, in 1935; and in 1937 was tranferred to Carbide's Fine Chemicals Division in New York, becoming manager of the Division in 1944. In 1954 he was appointed to his present position.

Other Major Petrochemicals

The future looks good from every angle

AUTHORITIES on each of the major petrochemicals have given PETROLEUM PROCESSING *the supply-demand picture in their specialties for 1956 and beyond. Here are the conclusions.* *The individual reports start on p. 108.*

AMMONIA: The fixed-nitrogen industry has had its economic foundation shaken, but the worst is probably over and the future looks promising. Current consumption of ammonia is about 70% of capacity.

AROMATICS: BTX consumption for 1957 will increase substantially over 1956. The octane race might affect availability and price of petroleum aromatics for chemical uses. Polyurethanes loom as large user of toluene.

BUTADIENE: Capacity equals demand now, but population growth and specialty uses will bring steady rise in consumption.

CARBON BLACK: The world market for carbon black follows the rubber market. A 2% increase in carbon black production is due in 1957, another 5% in 1958. Foreign markets are becoming more important.

CRESYLICS: Post-war domestic cresylic industry has reduced reliance on imports, curbed price variations. Petroleum is now a major source. Further expansion of demand waits on larger raw material supplies.

ETHYLENE production is still climbing fast—exceeding estimates. Polyethylene will not displace ethylene oxide as main ethylene consumer until 1961. This year's ethylene consumption to hit 4 billion lb.

FORMALDEHYDE: Demand is trailing capacity right now, but new uses should spur market in the foreseeable future. Preference continues for the "upgraded" type of formaldehyde rather than conventional 37% liquid concentration.

POLYETHYLENE: Sales will forge ahead with vigor. Conventional polyethylene capacity will increase to 800 million lb/ yr and rigid polyethylene to 450 million lb/yr by 1960.

POLYPROPYLENE: First commercial production has been started by Montecatini in Italy. Polypropylene future in films, coatings and fibers might compete in volume with polyethylene within next decade.

STYRENE: Outstanding 1957 development was 20-25% reduction in styrene price. Present producers continue to expand to keep pace with growing demand.

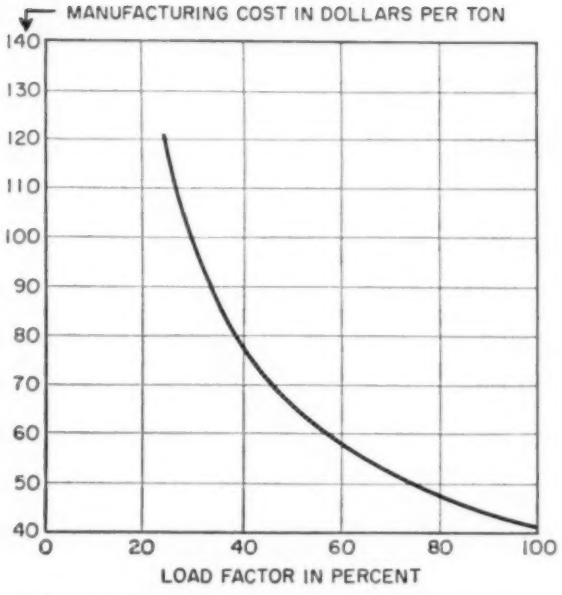
SYNTHETIC DETERGENTS: Continue to grow faster than soap. Nonionics are now competing with sulfonate standbys. New straws in the wind: an increase of liquid syndets and entry of syndets into the toilet bar field.

URETHANES: Foam production in 1957 will be 2½ times 1956's (10 million lb) with a total market of 100 million to 300 million lb by 1960. Urethane rubbers, now under test, have a promising future.

SULFUR: Use of sour crudes and demand for sulfuric acid assure "petrosulfur" producers room for expansion. Capacity may double by 1962. But they must reckon with Frasch process sulfur, which is often cheaper.

SYNTHETIC FIBERS: Sales have grown 50-fold in the past 20 years, and the fibers are still one of the fastest-growing chemical products. Clothing use, the major outlet today, will share more of the market with industry as a wide range of new uses is developed.

SYNTHETIC RUBBER: Capacity expansions have temporarily overshot demand, but rise in U. S. consumption will offer producers growing market during next few years.



EFFECT OF LOAD FACTOR on manufacturing cost for a 250-t/d ammonia plant.

Ammonia

Future looks promising

Meet the authors

Mr. Messing

Mr. Perkins

Richard F. Messing took his Bachelor's degree in chemical engineering at the University of Minnesota and did graduate work at Illinois Institute of Technology. Before joining Arthur D. Little, Inc., in 1945, he served as a research engineer with the government's Office of Scientific Research and Development. With the Little firm he has specialized in chemical market research, new product development, and technical investment analysis.

Samuel Perkins was graduated from M.I.T. with a Bachelor's in chemical engineering. He was for a time in charge of Research and Development at a small gelatine manufacturing firm, and he joined Little in 1951. He has been chiefly concerned with technology, market studies, and economic evaluations in various segments of the chemical industry.

THE gap between supply and demand for nitrogen products is being closed, and producers of synthetic ammonia and other nitrogen derivatives face the future with greater confidence than possible in the last several years.

Essentially all new synthetic ammonia facilities—a 92% increase in capacity since the end of the Korean War—are completed, with only minor additions known to be programmed. At the same time, demand has increased at a gradual pace because of the farmers' growing recognition of fertilizer benefits and the gradual improvement in the farm outlook.

Although consumption is only about 70% of present capacity, price concession pressures have been reduced, and recent action by major producers to increase quoted prices reflects growing confidence.

Synthetic ammonia, prime source of nitrogen chemicals for both agricultural and industrial uses, now accounts for about 83% of the total nitrogen supply in the U. S.—a sizeable increase over the 74% figure of 1950. At present, 52 plants, with a total nitrogen capacity estimated at 3.9 million tons/yr produce ammonia in the U. S. The remaining sources of nitrogen, including by-product ammonia from coke ovens, natural organics, and imports, represent about 500,000 tons of annual nitrogen supply.

The consumption of nitrogen for agricultural uses was an estimated 2 million tons in the most recent fiscal year. Although the growth of demand for agricultural nitrogen has tapered off during recent years, there has still been some increase in consumption.

Principal trends of the past year include growth in direct application of anhydrous ammonia, more use of ammonia in irrigation waters, some development in use of diammonium phosphate, and growth in application of fertilizers from bulk spreaders.

Industrial markets for ammonia now account for about 19-20% of the total usage, with major consumption by industrial explosives, synthetic fiber manufacture and petroleum refining.

In this period of below-capacity operation, producers are pressed to maintain margins in a field where capital investment is a significant portion of the total cost. Total operating costs, including depreciation, increase rapidly as capacity decreases—especially for plants built in recent years. The accompanying chart shows how manufacturing cost increases with decreased production for a typical plant with a capacity of 250 tons of ammonia per day. The absolute figures on the chart will vary from plant to plant, but the rate of change in manufacturing cost should be consistent for plants of this size. Generally, larger and older plants have lesser cost variation than shown, while smaller and newer plants have greater variation.

New ammonia plants are being built closer to the consumer as a result of new processes (using raw materials such as fuel oil) and the availability of raw materials. Many older producers, close to the raw material source but remote from the market, have a serious problem of higher freight-equalization costs.

Most of the older producers are concentrated in the Gulf Coast area, and until now were able to ship great distances at very little additional cost to them. Now, the wide geographical distribution of plants has reduced the marketing territory of the Gulf Coast plants and at the same time increased their freight-equalization cost as much as $10/ton of ammonia. The long-term trend toward increased consumption of fixed nitrogen will reduce this cost for many producers as the increased con-

sumption will permit a gradual withdrawal to the natural marketing territory.

In summary, the fixed-nitrogen industry has had its economic foundation shaken, but the worst is probably over and the future looks promising.

Aromatics

Fuels and chemicals boost BTX's

Meet the author

Harold Edward Bramston-Cook was born in England in 1899. He studied in England & Canada, receiving a M.A.Sc. in chemical engineering from the University of British Columbia in 1925. He has 30 years' experience in the oil and petrochemical industries, and is now a vice president and director of Oronite Chemical Co., San Francisco, with headquarters in New York.

Mr. Bramston-Cook

THE use of aromatics, particularly benzene and the xylene isomers, as chemical intermediates has shown a rapid growth trend during the past decade. So far, enough benzene, toluene, and xylene has been available from coal tar and petroleum sources to meet the growing demand for chemical uses. But an evaluation of the long-range future prospects suggests possible limitations on supply, or increased costs, because of the increasing need for these types of materials as octane improving stocks.

The traditional source of aromatics, coal tar, has been supplemented by petroleum sources, and the petroleum industry currently accounts for about 35% of the benzene, 80% of the toluene, and 90% of the xylene produced in the U. S. However, the petroleum industry is also one of the largest consumers of aromatics, particularly toluene and xylene. These materials, which are made by catalytic reformers, are among the highest octane number components available to the oil refiner.

The race for ever-increasing octane numbers to power the currently popular high compression-high horsepower automobile engines could have a far reaching effect on the availability and price of aromatics from petroleum sources.

A. L. Lyman, President of the California Research Corp., in a paper recently presented before the API, estimated that the majority of the cars on the road in 1965 would require fuel with 98-102 octane, and projected a demand for premium grade fuel at about 1.5 million b/d for 1965. The resultant need for such large quantities of aromatics in fuels will have its effect on the supply and price of aromatic chemicals.

During 1956, the apparent consumption of benzene and xylene in non-fuel uses increased substantially over that used in 1955, and toluene consumption showed a slight decrease. Based on U. S. Tariff Commission figures reported for the first four months of 1957, production in 1957 should be well ahead of 1956 for each of these aromatic chemicals.

It is estimated that the total availability of benzene (spec and industrial grades) in 1956 was about 368 million gal, compared to about 310 million gal in 1955. Care is needed in interpreting the Tariff Commission figures. For instance, in 1956 328 million gal is reported as production and 70 million as imports. However a substantial portion of the imports is reprocessed by U. S. tar distillers and reported as production. It is believed that about 30 million gal of the 1956 import figure was reprocessed, and should be eliminated in arriving at a total availability figure. In 1956, however, about 40 million gal of high quality Russian benzene was imported and used without reprocessing. Although this gives a total availability of 368 million gal, actual usage was closer to 320 million gal, because about 50 million gal were in inventory as of Jan. 1, 1957.

Toluene production in 1956 was 177 million gal compared to 186 million in 1955. Production figures for the first four months of 1957 indicate a probable annual volume of 220 million (up 24% over 1956) for 1957.

Xylene production was 128 million gal in 1956, compared to 108 million in 1955, an increase of 18%. Production figures for the first four months of 1957 indicate a probable production of 140 million gal in 1957.

Styrene manufacture continues the largest single chemical use for benzene, about 41% of the total. Since 1954, the requirements for benzene in phenol manufacture have grown to rank second in consumption, about 22% of the total. Adipic acid for nylon uses about 9-10% of the total, and so-called dodecylbenzene detergent intermediates use about 7-8% of the total.

For toluene, while uses in epxlosives, aviation gasoline and solvents in the coatings industries continue to be large consumers, an increasing quantity was used to make tolylene diisocyanates, used in polyurethanes. This rapidly growing field may, in part, account for the rapid increase in toluene production in the early part of 1957. In addition, large scale production of polymethyl styrene, made from acetylene and toluene, started in late 1956.

The recently-announced process for making terephthalic acid from toluene and urea chloride, developed at the Institute for Technical Chemistry of Martin Luther University in East Germany, may increase the chemical utilization of toluene.

Chemical uses of isomeric xylenes are largely tied to their oxidation products—dibasic acids or anhydrides. Orthoxylene has been used for several years as one precursor of phthalic anhydride, but in 1956, Standard Oil Co. of California started the first commercial isophthalic plant using metaxylene as feedstock. Late in 1956, Standard Oil Co. (Ind.) announced plans for a large plant to make phthalic anhydride, isophthalic and terephthalic acids with a xylene feedstock. The use of paraxylene for terephthalic acid and/or dimethyl terephthalic intermediates to make Du Pont's "Dacron," "Mylar," and "Cronar" continued to increase during 1956.

The outlook for continued and expanding chemical use of BTX aromatics is promising, although the competitive use as octane improvers will likely have a pronounced effect in the longer range picture.

Butadiene

Supply-demand now in balance

Meet the author

Mr. Norris

D. Eugene Norris is assistant process sales manager of Houdry Process Corp. A graduate of the University of Pittsburgh, with a B.S. in chemical engineering, Mr. Norris was with the former Socony-Vacuum Oil Co. during World War II and helped start up moving-bed crackers at refineries of Magnolia, Gulf, Ashland, Tidewater and Socony companies. He joined Houdry in 1946 as a technical service engineer. He has been with the process section of the engineering department and the commercial development and sales departments.

ECONOMISTS generally agree that by 1960 there will be a world requirement of 1,500,000 t/yr of synthetic rubber. Expansion of butadiene production facilities is already moving toward this level. In the past year capacity has increased from 740,000 t/yr to 1,065,000 t/yr, or 42%.

Existing plants have 67,000 t/yr of the increase, and new plants are supplying 250,000 t/yr. All of the new plants use the Houdry Dehydrogenation Process, with normal butane as raw material.

Before this year, butadiene was largely produced from petroleum-derived butylenes. These are now valuable as raw material for high octane gasoline, and the once-profitable practice of diverting them to petrochemicals is causing a squeeze on some refiners.

However, plants with butane dehydrogenation units can produce butadiene and butylene simultaneously and charge the latter to alkylation units for use as blending stocks.

Butadiene capacity at the end of 1957 will just about balance SB (GR-S) rubber capacity. But this ignores special uses, as in dibasic acids (nylon, for instance, is one end-product). Because of changes in economics, these special uses may grow. For instance, the Houdry Dehydrogenation Process in commercial practice is giving better yields and lower costs than originally projected.

A steady increase for butadiene is expected. Population growth alone will enlarge demand for rubber. Additional butadiene capacity probably will be built in anticipation of greater demand, either in areas without producing capacity now or where normal butane is plentiful and relatively inexpensive.

Other nations are looking at their imports of rubber—a drain on foreign exchange—and considering synthetic production. Wherever normal butane is available it is likely to be a first choice as raw material. Butane-butylene mixtures will be alternatives.

World production of natural rubber is expected to reach a ceiling of 2,000,000 t/yr in 1960. By 1965, world demand for rubber is expected to be at 4,400,000 t/yr, and 2,400,000 of this will be synthetic—an increase of 900,000 tons over 1960.

Polyisoprene (SN) rubber may be commercial in the next 5-10 years. It would be produced from a dehydrogenation product, isoprene. Most economical production of isoprene may be by dehydrogenation of isopentane (and the process scheme might include isomerization of normal pentane).

A process that will convert normal butane to butadiene and/or butylenes, and isopentane to isoprene, will also convert other paraffins to olefins. Where paraffins are in excess there is an incentive to convert them to higher value products. For instance, distress propane can be converted to polypropylene, to alkylate, or other desirable products.

Carbon Black

Foreign markets growing fastest

Meet the author

Mr. Heath

Gordon B. Heath is manager of Production Planning for Godfrey L. Cabot, Inc., Boston, Mass. He joined Cabot in 1945 to manage the statistical department after several years with Bendix Aviation and Sylvania Electric Products. In 1951, Mr. Heath became manager of Production and Sales Control, assuming his present position in 1956. His varied experience with both production and sales problems makes him well qualified to provide economic and statistical guides to the world-wide operation of the Cabot companies.

THE world market for carbon black continues to increase in almost direct proportion to the increase in rubber consumption. With the rubber industry accounting for about 94% of all carbon black consumed, changes in end-use of the remainder have little effect on this ratio.

The Free World outside the United States is increasing its rubber consumption at an even faster pace than the United States. Thus, as is true with many industries, foreign markets become increasingly important. Various established carbon black producers have built, or are building, plants in Canada, England, France, Brazil and Australia, and are constantly examining the potentials of other foreign markets.

Recent technological advances, the result of many years of research, permit the manufacture of a wide range of carbon blacks from liquid hydrocarbons rather than from natural gas. Such advances make the establishment of offshore facilities both practicable and economically sound.

As new production facilities are added, using liquid

hydrocarbons for fuel, they will serve not only the increased demand, but to some extent will represent replacement of existing channel black plants. These have become less desirable from an economic standpoint as natural gas costs increase.

The transition from channel black to oil furnace black usage continues as may be seen by the change in U.S. shipments of channel black (% of total carbon black shipped) from 50% in 1946 to 37% in 1951 and 22% in 1956.

There are many factors at hand and on the horizon that aid the growth of the carbon black market. The increasing per capita use of motor transport throughout the world, higher speeds, greater horsepower, a broadening utilization of rubber in mechanical goods, and the Federal highway programs—all contribute to such a growth.

The constant awareness of this growth has enabled the carbon black industry to anticipate future demand with the result that much of the production capacity available today is aimed at a sales volume yet unrealized.

Consumption of carbon black in the United States is expected to exceed 1.3 billion lb in 1957, up 2% from 1956, and will rise another 5% in 1958 to about 1.4 billion lb.

World consumption by 1961 should reach a level of 2.7 billion lb, up 35% from the 1956 total of 2 billion lb.

Carbon black prices have remained relatively stable in recent years, and have not had the sizeable increases witnessed in many commodities. For example, in 1956 the United States consumer of carbon black paid a weighted average price of 6.482¢/lb as against 6.571¢ in 1950, a decline of 1.3%. For the same period, the wholesale price index in the United States increased from 103.1 to 114.3, a rise of 11%.

Cresylics

Demand waits for supply

Meet the author

Mr. Pursglove

Joseph Pursglove, Jr., is vice-president for Research and Development of Pittsburgh Consolidation Coal Co. After his graduation from Cornell University in 1930 with an engineering degree, Mr. Pursglove entered the coal industry. In 1946 he began to study the methods for turning coal into chemicals and fuels. He surveyed coal mining and deposits in South Africa for Standard Oil Co. (N.J.) and developed a report on that country's suitability for a gasoline-from-coal plant. When he returned he joined Pittsburgh Consolidated Coal Co. as a vice-president. He was named president of Pitt-Consol Chemical Co. in 1955 when it was formed as a subsidiary to further Consolidation Coal's chemical activities. In 1956 he was also named president of Mountaineer Carbon Co., a firm jointly founded by Standard Oil Co. (Ohio) and Pitt-Consol to process coal.

DEVELOPMENTS in organic chemistry during and since World War II have increased the uses for cresylics. Earlier, coke-oven coal-tar processors were the only significant domestic source of cresylics. Certain mixtures of them had been imported, duty-free, for many years, from England.

World War II and the Korean conflict brought a critical shortage of cresylic acids because of new uses and the reduction of imports. During these shortages, cresylics fluctuated widely in price, their price swings greatly exceeding those of normally competitive chemicals. This led oil companies and others to investigate large-scale extraction from caustic waste streams in the early '40s. In 1955, Pitt-Consol Chemical Co., a subsidiary of Pittsburgh Consolidation Coal Co., purchased the New Jersey plant of Reilly Tar & Chemical Co. After extensive changes, Pitt-Consol reopened it last January to make 18 million lb/yr of refined, fractionated acids, primarily from petroleum-derived materials. Potential capacity is greater than 20 million lb/yr.

Here is how production and sources of cresylics have changed during the past 10 years:

Cresylics sources, 1948 and 1957

	Millions of lb	
	1948	1957
From domestic coal	18	68
From domestic petroleum	9	48
Imported (duty-free)	25	26
Total available in U.S.	**52**	**142**

It is apparent that petroleum-derived cresylics have become a major factor over the past 10 years and are now almost double imports; before, they were only about one third.

Progress has been made during the same period in improving the quality of cresylics from petroleum. Now, for example, sulfur and neutral oil contaminants can be almost wholly removed by a continuous solvent extraction process used for the first time in Pitt-Consol's new plant. These acids can for the first time be considered the equal of imported acids and the best coal-tar-derived acids or imported.

Some market prognosticators see about 65 million lb of cresylics from petroleum being produced in 1960-61. I do not foresee any such volume available from refinery operations for economical processing.

All refineries do not produce such materials, and they are often so dilute in caustic waste streams that they have no economic value. Geography also is an important factor in availability of these materials. To forecast that another 15 million lb could enter the cresylic markets from refineries in this country and Canada is stretching future possibilities well beyond my present knowledge.

Petroleum-derived cresylic refiners now draw on supplies from practically every oil refinery in the U.S. and Canada where the material is available and of economic quality. Petroleum refining experts say they do not believe cresylate supply necessarily keeps step with crude oil runs to refineries. In fact, some say that changing technology in oil refineries could even decrease the amount of cresylate available from petroleum sources in the next few years.

Following are estimated U.S. markets for cresylics:

Cresylics markets, 1957 and 1962

	1957	1962
Tricresyl phosphate	35	50
Phenolic resins	37	60
Wire enamel solvent	9	14
Ore flotation reagents	9	12
Metal cleaners	9	13
Disinfectants	10	11
Solvent refining	5	8
Misc. (pharmaceuticals, etc.)	21	32
Total	**135**	**200**

It can be seen, then, that ample supplies of cresylics are available from all sources to take care of the demand for the next few years. However, demand from existing uses could increase over the next four or five years if you assume that 1—petroleum sources will be increased by 15 million lb/yr during this period, and 2—imports will be constant at about 28 million lb/yr. These developments would necessitate 35-40 million lb/yr of new sources from coal.

Imports are at about the same level as 10 years ago, and any substantial increase is doubtful for two reasons: 1—there is a limit to the amounts that can be imported duty-free, and 2—the uses of cresylics in England and Europe are increasing just as they are here.

The production of cresylics by coal-tar processors will probably level off at 70 million lb/yr in the next few years and should remain unchanged. This is because steel producers will be producing much more pig iron with less and less coke over the next five years and thus, coke-oven coal-tar volumes will not increase much. Furthermore, high prices for low-sulfur fuel oil for open hearths increases the steelmaker's incentive to burn his own whole tars rather than have them processed. For these reasons, tar volumes available for processing might actually decrease over the next five years, despite an overall rise in steel production. Beyond the next five years one can see new developments in steel technology beginning to make coke ovens, and even blast furnace, obsolete, especially for new capacity.

Cresylics for the growth in use projected above could come from large-scale facilities for low temperature carbonization of coal. One such carbonization scheme, under development by Pittsburgh Consolidation Coal Co., alone could provide over 40 million lb/yr of new cresylics. It could also be easily expanded to double this production when demand required it.

The table of cresylic markets above anticipates growth only of present uses. What of new ones? Here is the best guess I can make of uses to appear for cresylics in the 1957-65 period:

Cresylics end uses

Possible use	Millions of lb/yr
Better, cheaper phenolic type resins	10 to 20
Esters	10 to 25
Substitutes, in existing uses, for more expensive chemicals	10 to 15
Total range possible	**30 to 60**

I know of several active laboratory and development projects in each of the groups listed, and I believe the new-use volumes shown to be realistic. A future shortage of supply seems remote, unlike past years, so new uses in large volumes can be pushed on all fronts by research workers without fear of shortage or wide price fluctuations.

Ethylene

Still a booming product

Meet the authors

Dr. McCleary

Mr. Glover

Dr. R. F. McCleary, general manager of the Research and Development Dept., Jefferson Chemical Co. Inc., was born in Ohio in 1909. He received an Ohio Northern University B.A. in 1931 and a Purdue Ph.D. in 1937. Before joining Jefferson in 1956, Dr. McCleary was with Krebs Pigment and Color Corp. in Delaware, Rohm and Haas Co. in Philadelphia, and, for 16 years, was with Texas at its Beacon, N.Y., research center.

John J. Glover, manager of the Commercial Development Div. of Jefferson received a B. Ch.E. from the Georgia Institute of Technology in 1946 and a M. Sc. in chemical engineering practice from M.I.T. in 1949. He came to Jefferson in 1949, after leaving Monsanto Chemical Co. He was market research manager at Jefferson before assuming his present post, and is active in the A.C.S. and the Chemical Market Research Association.

BOOMING ethylene production continues to top previous estimates. Consumption in 1957 should reach 4 billion lb; by 1961, 21 plants should be delivering 54 billion lb.

Because most of the best feedstock for ethylene—refinery off gases—is already committed to ethylene production, additional output will come from other hydrocarbons, principly propane and butane.

Other trends are:

- More production of high-purity ethylene for polyethylene, and for direct oxidation to ethylene oxide.
- More large-plant ethylene production with pipeline delivery to customers. Such sales reached 594 million lb in 1956, up to 16.5% of total production from 1955's 12.2%. Much of the soon-to-go-onstream production will also be sold.

Ethylene oxide, clearly the largest consumer of ethylene, as the table shows, will probably hold its position for a few years. Ethylene glycol, using some 60% of ethylene oxide production in anti-freeze, industrial and export uses, is, in turn, the largest consumer of ethylene oxide. Other large consumers are surface active agents, ethanolamines, and diethylene and polyethylene glycols.

Two new ethylene oxide producers are entering the field, and with announced plants and expansion completed, 1961 capacity should exceed demand.

New additions to capacity (which will bring it to 1.7 billion lb) will use mostly the direct oxidation process.

Therefore, the present 50-50 distribution of direct oxidation and chlorohydrination processes should change by 1960 to 60-40 in favor of direct oxidation, which uses, incidentally, more ethylene per pound than does chlorohydrination.

Ethyl alcohol. During 1955, production of ethyl alcohol from ethylene on a 190-proof basis was 1.2 billion lb or about 180 million gal. Total ethyl alcohol production during 1955 was about 235 million gal with the other 55 million gal coming from the fermentation process.

Production of ethyl alcohol from ethylene is expected to grow steadily to 245 million gal in 1961. This will require 1 billion lb of ethylene. Production by the fermentation process is expected to fluctuate up and down depending on the price of molasses and government action on use of excess farm products. During the first half of 1957, production of fermentation alcohol was very low but this is expected to increase when Cuban molasses becomes available in several months.

Polyethylene is showing the most rapid growth of all the major derivatives of ethylene. George Wash (see his article in this section) predicts that polyethylene production will be approaching 1.25 billion lb in 1960. From this we estimated that production would be 1.3 billion lb in 1961 which would require 1.43 billion lb of ethylene (see Table). We predict that polyethylene will become the largest consumer of ethylene by 1961, displacing ethylene oxide.

Styrene production continues to increase at a moderate rate. E. K. Stilbert (see his article in this section) estimates 1.3 billion lb of styrene will be produced in 1958. We estimate that 1.5 billion lb of styrene will be produced in 1961. This will consume 480 million lb of ethylene.

Ethyl chloride demand is closely related to the demand for tetraethyl lead. In 1955, 92% of the 542 million lb of ethyl chloride produced was made by hydrochlorination of ethylene. The other 8% was produced from ethyl alcohol. It is expected that the hydrochlorination of ethylene will be used to satisfy the increased demand for ethyl chloride in the future.

An estimated 400 million lb of ethylene will be required for ethyl chloride manufacture in 1961.

Ethylene dichloride demand continues to increase annually. Most ethylene dichloride is made by direct chlorination of ethylene and the percentage made by this method will probably increase because of the trend toward direct oxidation of ethylene to produce ethylene oxide with the resultant limitation on the quantity of by-product ethylene dichloride available.

The principal uses of ethylene dichloride are for the manufacture of vinyl chloride and the compounding of tetraethyl lead fluid. In 1956, 175 million lb of ethylene was converted to ethylene dichloride. We expect that 250 million lb of ethylene will be required for this purpose in 1961.

Other ethylene derivatives, though important, such as ethylene dibromide, have not been considered individually because they consume much less ethylene than the products mentioned above.

Ethylene Consumption (million lb)

Use	1955	1956	1957	1961
Ethylene oxide	910	1040- 29%	1090	1400- 26%
Ethyl alcohol	730	790- 22%	860	1000- 19%
Polyethylene	440	610- 17%	810	1430- 26%
Styrene	320	355- 10%	385	480- 9%
Ethyl chloride	240	290- 8%	320	400- 7%
Ethylene dichloride	150	175- 5%	185	250- 5%
Other	258	342- 9%	350	440- 8%
Total	3048	3602-100%	4000	5400-100%

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Formaldehyde

Capacity exceeds demand

Meet the author

Mr. Davis

T. G. Davis is product manager of intermediates at the Celanese Corp. of America. A graduate of the University of Maryland with a B.S. in chemistry, Mr. Davis joined Celanese in 1933 as a chemist in the Cumberland, Md., plant. He was transferred to the product development department of the chemical division in 1947 and moved to the sales staff as midwest district manager in 1950. In 1953 he was appointed to his present position.

ESTIMATES of present U. S. capacity for formaldehyde production range anywhere from 2.3 to 2.5 billion lb/yr. An exact figure is hard to cite because new capacity continues to be added. Probably 15% of the total was added in the last two years, either as new plant or expanded facilities. Let's compare actual production figures during this period.

Last year's survey (PP, Sept. 56, p. 112) reported that the total U. S. capacity was almost double the output anticipated for 1956. As of Jan. 1, 1957, special government surveys rated this capacity at 2.3 billion lb/yr. By the end of 1957 another 200-300 million lb of capacity will exist. One might question the logic of continuing to expand physical plant for a product that already exceeds capacity goals set by the Office of Defense Mobilization by an amount equal to one half a year's actual production.

Here are the U. S. Tariff Commission's production figures for formaldehyde:

1955	1.195 billion lb
1956	1.354 billion lb
1957 (est)	1.300 billion lb

Further analysis of actual production records shows that output for the first quarter of 1957 was only 326 million lb, as high as the last quarter of 1955 and well below the average quarterly production of 339 million lb in 1956. This reflects the lower activity of the housing, automotive, appliance and textile markets. There are signs of an improvement in certain areas—e.g., plywoods, furniture, and textiles—but the overall sideway movement of markets persists.

In marketing of formaldehyde the preference for higher concentration solutions continues. Also, more products containing formaldehyde are being developed, e.g., paraformaldehyde flake (Celanese), alcoholic solutions (Celanese Formcels), and complexes with urea (Allied Chemical's UF-85).

Nearly all major producers of the aqueous material offer 44-45% or 50% solutions, or both. Chief difficulty of such high concentrations is that in shipping and storage there is a tendency to "paraform" or settle out. And stability is affected by the high temperatures necessary for handling and storage. But high concentration solu-

tions offer the shipper savings on freight and the consumer savings in processing operations. They are thus replacing conventional 37% formalin where profit margins are critical.

Formaldehyde demand will no doubt reach a healthy level in the foreseeable future. Markets show signs of improving, and new end uses such as new synthetic fibers, fertilizers and rocket fuels could take sizeable quantities. Also, existing fields—phenolics, ureas and pentaerythritol for surface coating resins—will take more formaldehyde.

With present capacity more than adequate for present demand, the big question from the consumer's point of view is whether to plan his new plant and processes around "more of the same" or around an "upgrade" source of formaldehyde. The latter may consist of a higher assay liquid, a concentrated solid, or some formaldehyde-containing complex. But an important consideration will be raw material and processing costs vs. profit margins. Producers should consider this changing consumer attitude before adding conventional units to existing plants.

Synthetic Detergents

Grow at soaps' expense

Meet the author

Dr. Snell

Dr. Foster D. Snell is president of the firm of consulting chemists and chemical engineers bearing his name, and of associated companies. Dr. Snell has been engaged in consulting work since 1920.

From their beginning he has been closely associated with the development of non-soap detergents, which he was the first to dub "syndets."

SYNTHETIC detergents, more briefly "syndets," continue to be made and sold in ever-increasing amounts. For the past several years, a part of the increase in sales was at the expense of soap—the latter went down while syndets went up. However, a levelling-off in soap sales was indicated last year. During the first quarter of 1957, soap sales showed an increase of 6.5% over that of the previous quarter. Syndet sales also showed an increase amounting to 14.6% over the previous quarter's sales. In general, the detailed figures indicate that syndet sales will continue to advance in 1957 and 1958, while soap sales will show relatively little change.

The most important active agent in syndets is still sodium dodecyl benzene sulfonate, which is well over 50% of total syndet production. It has maintained its strong position because of detergent efficiency and low cost. The present tendency is to make it by continuous sulfonation, although small sulfonators will continue to use the batch process.

Competition from other types of syndets is on the increase, mainly nonionics. Both small and large companies continue to develop and market new nonionic syndets. Many of the companies already in the field, such as Olin Mathieson, Wyandotte, and Hart Products, continue to expand their line of nonionics. Berkeley Chemical is offering a new nonionic made from sucrose and fatty acids, the first of the series being a sucrose dipalmitate. Raw materials are low in cost, hence may be competitive with alkyl aryl sulfonates. Many of the new nonionics are for special applications. Another new product is a combination of nonionic and anionic.

In the household detergent field, the outstanding change has been the tremendous growth of liquid products. Originally made with nonionics, they are now made with a proportion of alkyl aryl sulfonate with light-duty products for dishwashing and heavy-duty for home laundry. The latter are built with tetra potassium pyrophosphate instead of a sodium polyphosphate.

Syndets can be expected to continue to find new applications, and have already become important in food processing for removal insects and larvae in berry washing. Syndets are being used to clean ships' deeptanks where soap is not satisfactory. Other new uses may involve syndet stability in acid and in electrolyte solutions.

Monsanto, maker of the household low-sudser "All" for automatic washing machines, has turned distribution of this product over to Lever Brothers. All of the three big soapers are making low sudsers for use in automatic machines, some types of which do not perform efficiently with too high a foam. In spite of this, ways to improve the foaming power of alkyl aryl sulfonates continue to be patented. High-foaming products continue to be popular for general cleaning and for hand dishwashing.

At long last, syndet bars have appeared on the market in quantity. Lever Brothers having advertised its Dove bar extensively. Thus syndets have penetrated the last stronghold of soap, the toilet bar field.

Polypropylene

A bright future waiting

Meet the author

Dr. Ottolenghi

Dr. Mario L. Ottolenghi, Vice-President and head of the technical department of Chemore Corp. since 1952, was born in Rome, Italy, in 1903. He attended Pisa University and the School of Engineering of Turin, receiving a Doctor's degree in chemical engineering in 1924. In Italy, he joined the new projects office of Montecatini Co. in 1925, and emigrated to the U.S. in 1939, where he was associated with American Cyanamid Co. until 1946. For the latter, he organized the research laboratory in East Taunton, Mass., and was later manager of production. Since 1947, he has been a technical advisor to the Montecatini Co. for the U.S. and Canada.

PROPYLENE is today the cheapest monomer available to the chemical industry to produce a range of high polymers, namely polypropylenes. Its end uses include all possible types of molded objects, clear films,

thermal and electrical insulations, filtration media, rigid and flexible pipes, fittings, fibers, cords, fabrics, blends with natural and synthetic fibers, and many others. Commercial production of the molding powder "Moplen" is just starting now at Montecatini's petrochemical center in Ferrara, Italy, and pilot-plant production of the synthetic fiber is also under way in Italy.

The general principles involved in the manufacture of isotactic and syndiotactic polymers were discovered by Professor Natta and Dr. Giustiniani, respectively. A very large field has been opened for research and industrial applications. The structural regularity obtainable with alpha olefins and with diolefins, using properly chosen stereospecific catalysts, is conductive to crystalline polymers with better physical properties than similar amorphous polymers of the same molecular weight. The degree of crystallinity can be controlled within a wide range to tailor the end product.

The general principles involved apply to a wide series of monomers, polymers and copolymers. However, the first products to attract widespread interest were the polypropylenes. Propylene is cheap, though its price may vary considerably with the location and method of production. In general its cost may be said to be at least one cent/lb lower than ethylene's.

With a growing demand in the coming years, propylene may cease to be the secondary product in the manufacture of ethylene. In such a situation, the prices of ethylene and propylene may become close to each other.

Propylene for isotactic polymers must be completely free from acetylenes and oxygenated compounds, but the presence of saturated hydrocarbons (propane and butane) and small amounts of other olefins is not harmful. The polymerization process is simple, so that the cost of polymerization is not higher than that of similar processes. The ratio of catalyst to polymer is low, with ratios of 1/1000 having been mentioned.

Polypropylene is very versatile. It can give a molding powder for use in all conventional fabrication machinery —extrusion, injection molding, compression molding, vacuum molding, film fabrication by extrusion and blowing, drawing and deep-drawing. Welding, tool machining and coating of paper, fabrics and aluminum foil are possible without difficulty. End products may be rigid or flexible and have a smooth (but not waxy) surface.

In the textile field, cords have been made that float on water and are as resistant as nylon. Blends, especially with wool, have a pleasant feel. Spin-dyeing is easy, and wet-dyeing is being developed.

Compare the future of polypropylene with recent growth history of polyethylene, which in the last 5 years rose from 50 million to 500 million lb/yr. But remember that polypropylene is cheaper and has superior physical properties (higher melting point, tensile strength and extrusion speed). In view of this, there must be a potential market of not less than 200 million lb/yr polypropylene, to be reached in 3 to 5 years. What will happen afterward will depend on the development of polypropylene fiber.

Since polypropylene may give the first completely synthetic fiber a price similar to fibers like rayon or acetate, a very rapid growth cannot be excluded. In such a case, propylene may become a commodity like ethylene in 7-10 years, with a network of pipelines, underground reservoirs, and a stabilized market price. Ethylene will, however, keep a market advantage with large volume uses in synthetic alcohol, ethylene oxide (and possibly synthetic linear fatty alcohols from low molecular weight ethylene polymers) until other large-scale uses for propylene are found.

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Polyethylene

Dynamic growth continues

Meet the author

Dr. Wash

Dr. George Wash holds a Ph.D. in organic chemistry from the University of Texas. He spent four years as a research chemist in the oil industry prior to joining Phillips Petroleum Co. in 1946. He is the author of several published technical articles on petrochemical processing. After serving Phillips in various technical and administrative positions, Dr. Wash was appointed Director, Plastics Sales Div., Phillips Chemical Co., when that division was organized in 1955. He is in charge of all sales and technical services for Phillips' rigid polyethylene, "Marlex 50."

THE continuing expansion of plastics production facilities, the advent of more companies in the field, and progress in technology indicate that last year's prediction for polyethylene will be realized, if not exceeded (see PETROLEUM PROCESSING, Sept. 1956, p. 114-5). Bakelite's Gordon Brown stated then that during the period 1955-1960, the consumption of plastics would double. Close cooperation of material suppliers and fabricators, guided by the Society of the Plastics Industry and the Society of Plastics Engineers, have established plastics in the public's mind as important prime materials.

In terms of growth, interest and versatility, polyolefins —particularly polyethylenes—have attained considerable eminence. Rigid polyethylene, polypropylene, copolymers of ethylene-propylene and ethylene-butylene are sharing publicity formerly limited to conventional polyethylene. Rigid and conventional polyethylene differ in important properties, such as molecular weight and structure, rigidity and strength. Polypropylene and copolymers have properties somewhere between the two polyethylenes and, it is reported, show better resistance to stress cracking and high temperatures than conventional polyethylene.

Rigid polyethylene is now a commercial reality, with plants producing both Phillips and Ziegler type materials. A recent announcement said commercial polypropylene capacity will be built in the U.S. by an Italian firm. Copolymers are being investigated actively, but no production plans have been announced.

Conventional polyethylene, with well-established and expanding markets, is predicted to show a gain in domestic productive capacity from the present 600 million to 800 million lb/yr by 1960. Demand may lag slightly during some of that period, but is expected to equal supply by early 1960.

Rigid polyethylenes have presently completed domestic facilities of about 125 million lb/yr, with a growth in

capacity to 450 million lb/yr by 1960. Redesigning and building new molds for improved economy, new market development, and product testing may cause demand to lag behind capacity until early 1960.

Most conventional polyethylene producers have added medium density resins (from high pressure processes) to their lists of products in the past year.

Newer developments for polyethylene include vacuum forming and extrusion of filaments from rigid polyethylenes. Vacuum forming from rigid polyethylene sheets permits fabrication of large rigid items with inexpensive molds to permit operation for small volumes of articles not justifying injection molds (or where the article is too large for economical injection molding).

Extruded filaments from rigid polyethylene have tensile strengths of the same magnitude as nylon, but unlike nylon, do not absorb water and lose strength and dimensional stability. Articles, from sheer women's hose to tough industrial marine ropes that float, have been made from these filaments.

A recent announcement states that 50% or more carbon black can be incorporated with polyethylene to overcome creep, fracture, and plastic flow, and improve high temperature behavior, resistance to stress cracking, and burst strength. This would materially broaden polyethylene uses, particularly in the pipe field.

Announcements and "shop-talk" in the industry boil down to this fact: polyethylene will forge ahead with vigor, but with strong efforts by producers to obtain technological advantages in a very competitive market. The various polyolefins will overlap somewhat in their fields of application, but for the main each will find its major niche in fields best suited to its particular properties.

Styrene

Price down—supply, demand up

Meet the author

Mr. Stilbert

Elmer K. Stilbert, manager of Coating Materials for Dow Chemical Co.'s Plastics Dept. since July 1956, joined Dow in 1940. He became assistant manager of Coatings Technical Service in 1949, holding this position until his present assignment, except for one year as manager of priorities and allocations. Mr. Stilbert is credited with several patents in the coatings field, and is the author of a number of papers on coating materials He is a native of Hartford, Conn., and holds B.S. and M.S. degrees in chemistry from New York State College of Forestry, Syracuse University.

THE most important change in the styrene picture during 1957 has been the approximate 25% reduction in price of rubber-grade styrene and the concurrent 20% reduction in polymer-grade styrene. Very shortly following the monomer price change, downward changes in poly-styrene molding materials and styrene-butadiene latexes were announced by suppliers.

Since synthetic rubber is only 22% styrene, it is not expected that the rubber price will be affected by the styrene change. At 12.5-16¢/lb for bulk styrene (depending on grade), it is among the lowest priced plastic monomers on the market.

Present producers continue to expand facilities to keep pace with the growing demand for styrene. Foster Grant is reported to be doubling its capacity to 50 million lb/yr this year. Very recently, Monsanto announced it would add 40 million lb/yr to its facilities at Texas City, Texas, by 1958.

A new producer, Cosden Petroleum, is in production at Big Spring, Texas, a new, slightly modified process based on ethylbenzene separated from gasoline. Another new producer, Odessa Styrene, expects to be in production in 1958. Announcements of other possible styrene producers were tentative, and the companies later dropped their production plans.

Optimism for the future of styrene is well based. The totals shown in the accompanying chart should be considered conservative in view of the new low price. The chart also shows the major use categories for styrene compiled from the U.S. Tariff Commission Report for 1955 plus estimates for the years 1956, 1957 and 1958. Most of the growth is expected in the major categories—synthetic rubber and molding materials.

Increased use of styrene in rubber as charted is based primarily on expected growth in rubber production rather than increase in the proportion of styrene in the polymer. By late 1957, synthetic rubber manufacturing capacity will be 40% above that of 1955.

With synthetic rubber continuing at lower prices than natural rubber, more replacement of natural can be expected even if the total U.S. rubber use does not expand. The shift to more synthetic will also be aided by the continuous product improvement apparently characteristic of the new private synthetic rubber industry. If the industry increases the proportion of styrene to reduce raw material costs, further gains in styrene volume may be expected.

Increased use of styrene in molding materials reflects new developments in easy fabricating materials and improved properties throughout the range of poly-styrene products. The new lower prices will keep standard polystyrene molding materials strongly entrenched in the large volume, low cost markets. Thus the market for molding materials may be expected to continue its steady growth.

Although styrene is widely used in the manufacture of protective coating materials, polyesters and styrene-butadiene resins are the only uses that consume large volumes of styrene. Both are expected to show continued modest growth.

During 1957, extensive development work on water-thinned styrene-butadiene polymers for industrial finishes has resulted in their commercial use in several special applications. Acceptance of this type of finish by industry could result in a much faster growth rate of styrene coatings beyond 1958.

Estimated styrene use

	Millions of lb for:			
	1955	1956	1957	1958
GR-S rubber	380	450	450	500
Molding materials	435	475	500	550
Protective coating resins	125	135	140	150
All other	60	90	110	100
Total	1000	1150	1200	1300

Sulfur

Capacity may double by 1962

Meet the author

Mr. Emison

Sam S. Emison, vice-president of Stauffer Chemical Co., is responsible for directing sales of industrial chemicals. He was a graduate in chemical engineering from Rice Institute in 1925 and joined Consolidated Chemical Industries in Houston the same year. Later, he was superintendent of the eastern plant, then the Ft. Worth plant, and in 1941 became general manager of CCI's sales. In 1955, when CCI became a division of Stauffer Chemical Co., Mr. Emison was appointed a vice-president.

SULFUR recovered from natural or refinery gases (correctly called "petrosulfur") lately has been overshadowed by the competition between imported Mexican mined sulfur and domestic Frasch sulfur. Though attention has been focussed on increasing production of Frasch sulfur, output of recovered sulfur is on the rise too, as is shown by the list of new and abuilding capacity.

U.S. production of recovered sulfur for this year is estimated at 500,000 long tons. Last year it was 450,000 long tons. Planned capacity indicates that output will reach 650,000 long tons in 1958, and the general trend points toward 1,000,000 long tons by 1962.

This growth is caused by a number of factors, all or some of which may apply to any one company in any one location. These are: the need to refine crudes of higher sulfur content today, the demand for higher quality petroleum products and sweet gas, municipal air pollution regulations, and, of course, potential profits from a previously-flared waste material.

Our low-sulfur oil and gas reserves are being depleted, leaving crudes and gas high in sulfur content such as in the Middle East. This change from sweet to sour crudes has a profound effect on the market. In France, for instance, sulfur imports were 300,000 t/yr before discovery of the sour crude field at Lacq. Now 50,000 t/yr are being recovered, and within five years additional capacity will more than supply France's needs, enabling export of sulfur. Similarly, the largely sour gas reserves of western Canada will become increasingly important.

Refineries and gas plants, though now handling comparatively sour feedstocks, are at the same time expected to turn out products with improved color and odor. Also, within the refinery, desulfurization is becoming increasingly necessary to prevent poisoning of reformer catalysts and to otherwise upgrade stocks. Therefore, more hydrogen sulfide is present in stocks.

A few years ago, when sulfur was in short supply, many refiners installed recovery capacity both for profits from sales and for the acid needed in their own operations. Many producers have found, though, that plant size, location, and production economics largely determine whether they can compete with Frasch sulfur.

A refinery or natural gas plant can't sell at the market price of mined sulfur unless it can guarantee customers large supplies on a consistent schedule. Generally speaking, to be competitive today output must be at least 30 t/day and must be available at a place not within easy reach of Frasch sulfur. Where air pollution is the primary problem, not production of sulfur or sulfuric acid at a profit, small, semi-automatic package units can be installed.

The producer is better off, too, if he moves his product as a liquid—the modern way to move materials and a current trend in the sulfur industry. Not only will this cut delivery time to his customers, but the cost of melting is eliminated as well. Also, because he ships the liquid as it is produced he saves the expense of solidifying and handling the solid, and he carries practically no inventory (and suffers no losses from storage, etc.). What's more, liquid petrosulfur is of high quality, having low ash content, low acidity, and no organic matter—resulting in a beautiful, pure yellow product. Many users have found that filters needed to remove impurities from crude lump sulfur are unnecessary with the liquid petroleum product.

Where the end product is sulfuric acid, it is often to the producer's advantage to make sulfur and then burn it. Many producers burn hydrogen sulfide, but over the long range—especially for a new plant—it is more economical to reduce to sulfur as a first step. The deciding factor is that a so-called wet purification acid plant involves much greater investment than a straight sulfur-burning acid plant.

Principal sulfur recovery plants

(NG=natural gas feedstock; RG=refinery gas feedstock)

DOMESTIC

Aurora Gasoline Co.,
Detroit, Mich. RG

Columbian Carbon Co.
Seminole, Texas. NG

El Paso Natural Gas Co.
Eunice, Texas. NG

Freeport Sulphur Co.
Eagle Pt., N.J. RG

Great Northern Oil Co.
Pine Bend, Minn. RG

Gulf Oil Corp.
Philadelphia, Pa. RG
Port Arthur, Texas. (2) RG
Waddell, Texas. NG

Hancock Chemical Co.
Wilmington, Calif. RG

Hancock Oil Co. of Calif.
Long Beach, Calif. RG

Imperial Sulfur & Acid Co.
Fruitland, N.M. NG

Jefferson Lake Sulphur Co.
Manderson, Wyo. NG

Leonard Refineries, Inc.
Alma, Mich. RG

Monsanto Chemical Co.
El Dorado, Ark. RG
Magnolia, Ark. NG

Montana Sulphur & Chem. Co. Billings, Mont. NG

Olin Mathieson Chemical Corp.
Magnolia, McKamie, Ark. NG

Pan American Petroleum Co.
Elk Basin, Wyo. NG
Slaughter, Texas. NG
North Cowden, Texas. NG
Midland Farms, Texas. NG

Parker, J. L.
Madill, Okla. RG
Penwell Field, Texas. NG

Parker-Signal Oil Co.
Weber Dome, Wyo. NG

Phillips Chemical Co.
Goldsmith, Texas. NG
McElroy, Texas. NG

Pure Oil Co.
Lemont, Ill. RG

Seaboard Oil Co.
Silver Tip, Wyo. NG

Shamrock Oil & Gas Corp.
Sunray, Texas. RG
Pampa, Texas. NG

Shell Chemical Co.
Deer Park, Texas. NG

Sid-Richardson-Odessa Natural Gas Co.
Odessa, Texas. NG

Sid-Richardson Gasoline Co.
Keystone, Texas. NG

Signal Oil & Gas Co.
Tioga, N.D. NG
Minot, N.D. NG
Worland, Wyo. (2) NG

Sinclair Refining Co.
Houston, Texas. RG
Marcus Hook, Pa. RG

Standard Oil Co. (Ind.)
Whiting, Ind. RG

Stauffer Chemical Co.
Baytown, Texas. RG
Baton Rouge, La. RG

Sun Oil Co.
Marcus Hook, Pa. RG

Texas Gulf Sulphur Co.
Worland, Wyo. NG

Tidewater Oil Co.
Delaware City, Del. RG

Union Oil Co. of Calif.
Los Angeles, Calif. RG
Oleum, Calif. RG
Santa Mario, Calif. RG
Wilmington, Calif. RG

Warren Petroleum Co.
Monument, N.M. NG

Wilshire Oil Co.
Norwalk, Calif. RG

FOREIGN

British American Oil Co.
Pincher Creek, Alta., NG

California Texas Oil Corp.
Pernis, Holland. RG

Carribean Petroleum Co.
Puerto Rico. RG

Lago Oil & Transport Co.
St. Nicholas, Aruba, RG

Laurentide Sulphur
Montreal East, Canada. RG

Petroleos Mexicanos
Pozo Rica, Mexico. RG

Royalite Oil Co.
Turner Valley, Alta., Canada. RG

S.N.P.A.
Lacq, France. NG

Shell Oil Corp.
Jumping Pound, Alta., Canada. NG

Under construction or planned

DOMESTIC

Allied Chemical & Dye Corp.
(General Chemical Div.)
Bayway, N.J. RG 1958.

American Oil Co.
Yorktown, Va. RG 1958.

Commerce Oil Co.
Providence, R.I. RG 1958.

Fletcher Oil Co.
Wilmington, Calif. RG 1958

Stauffer Chemical Co.
Baytown, Texas. RG 1958.

Synthetic Fibers

Sales going up fast

Meet the author

Dr. Soday

Dr. Frank J. Soday, a vice-president and director of Research and Development for Chemstrand Corp., was formerly director of R&D for Lion Oil Co. Before that he was with Devoe & Raynolds Co., Louisville, Ky., where he directed research and development of resins and protective coatings.

He received a B.S. degree in chemical engineering at Grove City College, and M.S. and Ph.D. degrees from Ohio State University.

During World War II he was Technical Director for Copolymer Corp., which operated the government's Baton Rouge synthetic rubber plant. Before the war he was with United Gas Improvement Co., Monsanto Chemical Co., and the Pennsylvania Grade Crude Oil Assn.'s Central Research Labs.

SYNTHETIC fibers—from petrochemical raw materials—are one of the fastest-growing products of the chemical industry. Sales in 1956 were about 500 million lb, which represents a 50-fold increase in only 20 years.

Synthetic fiber consumption is expected to reach 975 million lb/yr by 1960, and 4 billion lb/yr by 1975, according to the President's Materials Policy Commission. Though the latter figure seems high, it is on a smooth growth curve of consumption plotted from 1940 to 1975. These forecasts can be broken down by major fiber type as follows:

Type	1960 prod.	1975 prod.
Acrylic	325	1200
Nylon	300	800
Polyester	150	1000
Other	200	1000
Total	**975**	**4000**

These are some of the reasons for this growth:

- Synthetic fibers can be obtained from petrochemical raw materials by well-developed processes.
- They can be produced to meet the precise specifications of the fabric and apparel industries.
- They are stable in price, unlike natural fibers.
- The synthetics have outstanding properties for certain applications (e.g., the strength and abrasion resistance, yet luxurious appearance, of nylon stockings).

Domestic consumption of textile fibers is customarily divided into apparel (45%), industrial (30%) and household uses (25%). Total domestic consumption of all fibers in 1955, per capita, was 23.3 lb of cotton, 7.6 lb of rayon and acetate, 2.9 lb of wool, and 2.7 lb of synthetics. Total, 38.5 lb per capita. A careful survey of fiber consumption over the past 30 years has shown that per capita use is increasing at a moderate rate.

Some 800 synthetic or semi-synthetic fibers are being developed or produced throughout the world today. Price varies widely by composition, type, denier, and count, but the weighted average today of all synthetic fibers is probably around $1.40/lb. The volume of consumption and quantity of chemicals required for processing make synthetic fibers a billion-dollar industry.

It's a southern industry, too, owing its location there to the presence of the textile industry. Textiles are the largest single outlet for chemicals, and synthetic fibers are largely from petrochemicals (only minor amounts are from coal and agricultural products). The textile plants are also needed to make the synthetics into yarns and fabrics. Thus it was a logical region for the synthetic fiber industry.

The major synthetic fibers and their manufacturers are as follows:

Acrylics: Acrilan (Chemstrand Corp.), Orlon (Du Pont Co.), Verel (Eastman Chemical Products).

Polyamides: Caprolan (Allied Chemical & Dye Corp.), I.R.C. Nylon (Industrial Rayon, Inc.), Nylenka (American Enka Co.), Nylon (Du Pont Co.).

Polyesters: Dacron (Du Pont Co.).

Vinyls: Dynel (Union Carbide Chemicals Co.), Saran and Vinyon (various companies).

New fibers, recently announced, include American Cyanamid's Creslan (acrylic), Dow Chemical Co.'s Zefran (acrylic), and Goodrich's Darlan. Besides construction of new plants for these fibers, existing plants for established fibers are being expanded, and Du Pont is building an additional nylon plant at Richmond, Va.

Synthetic fibers, as a class, are good heat insulators, are mold and mildew resistant, and do not absorb moisture greatly. The acrylics are wool-like in appearance, are rich to the touch, and can be easily dyed. The polyamides possess outstanding strength and abrasion resistance. The polyesters are highly resilient and have good wearing properties.

These fibers are finding wide use in the apparel industry and are becoming important in industry. Production of bulk yarns from acrylic yarns greatly increased the use of acrylics for sweaters. The texturized (crimped or false

twist) nylon yarns in many woven or knitted structures promises to greatly expand nylon's use for clothing.

The new isotactic polymerizing procedures convert simple olefins—ethylene and propylene, for instance—to high-melting polymers capable of being spun to fibers having good properties. It is entirely possible that, with these advantages, polyolefin fibers may become a major factor in the synthetic fiber field.

Urethanes

Market grows for foam

Meet the author

Mr. Ayscue

Mr. William H. Ayscue is isocyanates sales manager for Du Pont's Elastomer Chemicals Dept. He joined Du Pont as a chemist at Deepwater Point, N. J., in 1935, after receiving a M.S. in chemical engineering from North Carolina State College. He moved to the rubber sales office in Wilmington, Del., as a technical demonstrator in 1938, becoming a salesman in 1943. Four years later he was assigned to the Akron, Ohio, sales office. He was named sales supervisor in Chicago in 1951, next became assistant sales manager, and then took his present position.

URETHANE foams are among the newest, most versatile groups of engineering materials on the market today. They are strong and lightweight and can be made in a broad range of densities and hardnesses.

Isocyanates (which are reacted with resins to make urethanes) have been known for over 100 years, but remained laboratory reagents until the mid 1930's, when methods of using isocyanates to make high polymers were discovered.

Work in the field was almost dormant during World War II. By 1956, about 10 million lb of urethane foams were made. Production was distributed mainly among automotive, furniture, clothing, rug underlay, shoulder pads, mattress topper pads, sponges, and miscellaneous markets.

Urethane foam production in 1957 will be about 25 million lb, with an estimated rise to 100 million lb/yr within the next three years. Some companies envision a total market of up to 300 million lb by 1960.

Leaders in foam development and sales are American Latex, Armour & Co., F. Burkhart, Wm. T. Burnett, Curtiss-Wright, Sheller Mfg. Co., (Dryden Rubber Div.), Dayton Rubber Co., Firestone, General Tire & Rubber Co., B. F. Goodrich, Goodyear, Hadley Bros., Uhl Co., Hewitt-Robins, Inc., Inland Div. of General Motors, Nopco Chemical Co. (Plastics Div.), Rainbow Industries, Reynolds Chemical Co., and U. S. Rubber Co.

For the long run, it is believed that rigid urethane foams will find important usage as low temperature insulation materials and as structural materials, particularly in "sandwich-type" construction panels. These foams are well suited for these uses because they have a relatively low K factor and considerable compression and tensile strength. In addition, these foams may be foamed-in-place by pouring or spraying. They adhere to most common materials during and after foaming.

Foaming-in-place properties of the urethanes might account for future penetration into the insulation markets because of the resulting assembly cost savings.

Resilient urethane foams will capture some of the latex foam market, and there is also a large potential in uses where latex foams are not suitable. It has been estimated that the total consumption of resilient foams of all kinds is likely to grow 50-100% between 1957 and 1962. The urethane foam share of this market will be large—as much as 50% or more.

Propylene, a refinery product, will play an important role in making the polyether urethane foams of the future. These foams, which are made from propylene glycol and its derivatives reacted with isocyanates, have excellent cushioning properties. The result of the most recent technical developments, the propylene polyether foams are just beginning to reach the market. These newest urethane foams can truly be classified as petrochemical products, since toluene (in the diisocyanates), as well as propylene (in the resin), are used in their manufacture. Urethane foams are also made from adipic acid polyesters.

Another type of urethane product, urethane rubbers, currently is being evaluated. Having outstanding resistance to abrasion, these rubbers are of special interest for tire treads and other articles subject to high wear in service. In addition, urethane rubbers have excellent low-temperature characteristics and good resistance to heat deterioration, ozone cracking, weathering and oil or solvent swelling.

Synthetic Rubber

Slow now, but rise is coming

Meet the author

Dr. Cox

Dr. John T. Cox, Jr., is a partner in the firm of Cox & Weinrich, Consulting Chemical Engineers. He holds B.S. (in chemical engineering) and M.S. degrees from Louisiana State University, another M.S. from Massachusetts Institute of Technology, and an honorary Doctor of Engineering from Case Institute of Technology.

After taking his M.S. at M.I.T. in 1936 he joined Firestone Tire and Rubber Co. as a research chemical engineer. In 1940 he transferred to the newly formed synthetic rubber division, becoming technical manager at the southern plant Firestone operated for the government. In 1944 Dr. Cox went to Washington to form a synthetic latex division in the Rubber Reserve Co.

He later advanced to deputy director of the Office of Rubber Reserve and was in charge of the agency's synthetic rubber section, production division, when he left the government. He also served on the president's Scientific Research Board. From 1950-54 he had his own practice as a consulting chemical engineer, then joined Whitney Weinrich to form Cox & Weinrich.

CONSUMPTION of synthetic and natural new rubber in the U. S. was 1.48 million long tons in 1957. Although this isn't as high as in the record year of 1955, it is 4% over 1956. The outlook for 1958 is for a small increase over 1957.

The synthetic rubber industry has seen tremendous expansion over the past several years. In 1955, when industry bought the plants from the government, total synthetic S-rubber capacity was slightly more than 700,000 t/yr. By the end of this year it will be about 1.4 million long tons. These expansions were certainly not made by people worried about the future of S-rubber. Capacity has outstripped consumption, however, and there is now a temporary lull in the industry.

In 1958 producers of S-type rubber will probably have to decide whether to cut back production or attempt a boost in synthetic consumption at the expense of natural. One clue to what may happen is the recent growth in use of synthetic. In 1956, 60% of new rubber consumed was synthetic, and the ratio of synthetic to natural stayed relatively constant all year. In 1957 synthetic has captured a slightly larger share—63%. Since it takes seven years for a rubber tree to reach maturity, it's possible to predict the available supply of natural rubber for the next few years with reasonable accuracy, and there is little likelihood it will exceed 1.9. million t/yr. World consumption of rubber will gradually expand during the same period, so that synthetic rubber capacity will have to increase by 110,000-160,000 t/yr to bridge the gap.

The big feature for U.S. producers in the past few years has been the export market, because the only synthetic production of any consequence has been in this country and Canada. The export demand is high, and this has been the major outlet for excess capacity and inventories of synthetic in the U.S. But synthetic plants are now under construction in England, Italy and Germany, with completion scheduled for 1958. These, and others under consideration, may limit—or even cut back—the export market in the future.

Butadiene has seen a tremendous expansion within the past few years, and capacity at the end of 1957 will be about 1.1 million tons. This is more than enough to supply existing S-rubber plants, and surplus of butadiene in 1958 is estimated at 300,000 tons. This surplus will stimulate research into uses for butadiene other than S-rubber. It is likely that new polymers will be developed that will further replace natural rubber in fact, several new types appear promising.

Surplus of capacity should be no cause for concern. Synthetic will have to supply the difference between increasing world consumption and relatively fixed natural rubber production. Also, because many rubber producers are also rubber fabricators, they will probably try to boost their use of synthetic rather than cut back production and have idle capacity on their hands. Exports will probably not increase, but the rise in consumption predicted for the U.S. through 1960 will bring demand and supply into line.

Butyl rubber was first used for inner tubes. But the tubeless tire dealt the industry a severe blow. However, butyl has made a surprising recovery, largely because more butyl is being used in mechanical rubber goods. A strong effort is now being made to promote its use in automobile tires. A good way to start an argument in a group of rubber experts is to speculate about the future of the butyl tire.

When the two butyl plants were sold, total capacity was 95,000 t/yr. Petroleum Chemicals, Inc., has now announced plans for a new 30,000 t/yr plant. If butyl is not successful in tires, this should be ample capacity for some time. If butyl catches on, substantial new capacity will be needed.

Neoprene and nitrile rubbers have properties very different from natural rubber. For the most part they have specialty applications, most of which could not be filled by natural rubber. They are excellent examples of what can be done with specialty elastomers.

In about a third of current rubber applications, natural rubber has properties superior to existing commercial synthetics. This limited dependence on natural rubber may not last much longer. There have been several announcements of small-scale synthesis of suitable replacements for natural rubber. Two types—polyisoprene and polybutadiene—appear promising. The former seems to have properties that would permit it to replace natural rubber altogether. But producing it competitively with natural rubber depends largely on availability of low cost isoprene. There are no signs that this is just around the corner.

The starting material for polybutadiene is cheaper, which might make this less expensive than polyisoprene. Indications at present are that polybutadiene could replace only one fourth to one half of the natural rubber. This could, of course, be important during periods of shortage or high prices.

U.S. S-type polymer production capacity

(Year end)

Company	Long tons 1956	1957
American Synthetic Rubber Corp.	43,500	68,500
Copolymer Rubber & Chemical Corp	60,000	75,000
Firestone Tire & Rubber Co.	190,000	230,000
General Rubber Synthetics Co.		40,000
Goodrich—Gulf Chemicals, Inc.	232,000	242,000
Goodyear Synthetic Rubber Corp.	160,500	241,000
Phillips Chemical Co.	72,000	130,000
Shell Chemical Co.	126,000	126,000
Texas—U. S. Chemical Co.	127,000	127,000
U. S. Rubber Co.	25,000	30,000
United Rubber & Chemical Co.	62,000	68,000
Total	**1,098,000**	**1,377,500**

U.S. butadiene production capacity

(Year end)

Company	Short tons 1956	1957
Copolymer Rubber & Chem. Corp.	30,000	30,000
Dow Chemical Co.	12,500	17,400
Esso Standard Oil Co.	40,000	50,000
Firestone Tire & Rubber Co.		40,000
Goodrich—Gulf Chemicals, Inc.	110,000	110,000
Humble Oil & Refining Co.	49,000	65,000
Odessa Butadiene Co.		50,000
Petroleum Chemicals, Inc.	70,000	80,000
Petro-Tex Chemical Corp.	115,000	200,000
Phillips Chemical Co.	91,000	112,000
Shell Chemical Co.	70,000	70,000
Standard Oil of California	16,000	16,000
Texas Butadiene & Chemical Co.		80,000
Texas—U. S. Chemical Co.	110,000	110,000
Union Carbide Chemicals Co.	35,000	35,000
Total	**748,500**	**1,065,400**

Petrochemicals—1957

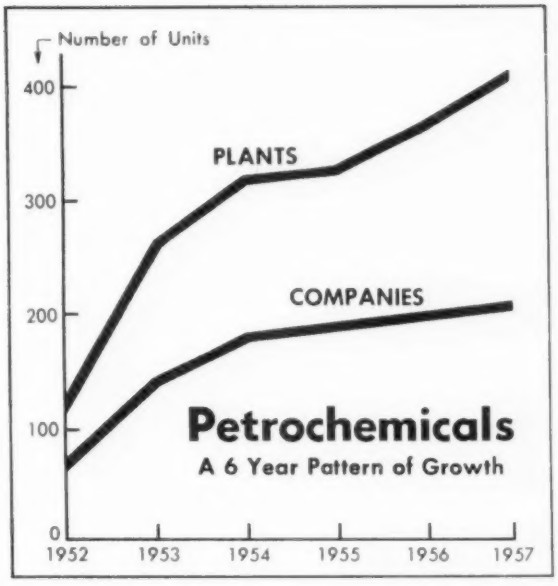
A 300% Increase in Six Years

A THREE-FOLD increase in six years. That's the picture of today's petrochemical industry in the United States and Canada as shown in the chart, completed from PETROLEUM PROCESSING'S six annual industry surveys.

In terms of companies, the rise from 1952 to 1957 has been from 70 to 206. In terms of plants—operating, building or planned—the jump has been from 130 to 409. In terms of dollars: today's estimated investment in existing plants is in the range of $4-5 billion, with another $1 billion-plus pegged for current new plant construction and expansion programs.

Other highlights of the industry's status as revealed in PETROLEUM PROCESSING'S Sixth Annual Survey:

- There are now 206 companies and 409 plants in the U.S. and Canada, in operation, under construction, or planned.
- Of the 206 companies, 66 are petroleum firms and their subsidiaries, 76 are petrochemical enterprises, 56 are chemical firms, and 8 are joint ventures of petroleum and chemical companies.
- There are 74 entirely new plants under construction or planned and 55 expansion projects at existing facilities underway or planned.
- Project completions since the last survey by PETROLEUM PROCESSING a year ago total 73.
- A number of shifts and transitions have occurred since the 1956 report. This year's survey shows 37 new entries in the listings, 7 projects cancelled or deferred, and 5 older units in which operations have been suspended.



Details of the entire petrochemical industry are given in the following pages. Information in this directory has been furnished by the individual companies, augmented by data from other sources, as in the past.

The glossary of products, a new feature started last year, is again a part of the report. It starts on p. 000. This glossary lists all products reported in the directory and provides brief descriptions of most products. For further instructions on how to use the glossary, see box below.

Petrochemical Plants in the U.S.

A

AETNA OIL CO.
Louisville, Ky.
Remarks: No petrochemical plans at this location.

AIR REDUCTION CHEMICAL CO. 1
Calvert City, Ky.
Approximate original investment: $3,000,000
Products and output:
Vinyl acetate—30-million lb/yr
**Methyl butynol—3-million lb/yr
**Vinyl stearate—2-million lb/yr
Personnel: O. W. Fortner, mgr; J. W. Frevert, supt and chf engr.
Remarks: **Building, completion late 1957. Subsid of Air Reduction Co, Inc.

ALLIED CHEMICAL & DYE CORP.
(Barrett Division) 2
Frankford, Penna.
Hydrocarbon raw materials:
Propane-propylene blend
Products and output:
Phenol—30,000,000 lb/yr
Acetone
Personnel: Thomas Lee, mgr; J. C. Shea, supt; J. T. Keating, chf engr.

ALLIED CHEMICAL & DYE CORP.
(General Chemical Division) 3
El Segundo, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfuric acid—150,000 ton/yr
Personnel: Geo. W. Miller, mgr; W. B. Yarborough, chf engr.
Remarks: Refinery gases are supplied by Standard Oil Co. of California.

ALLIED CHEMICAL & DYE CORP.
(General Chemical Division) 4
Richmond, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfuric acid—100,000 ton/yr
Personnel: D. L. Hicken, mgr; W. B. Yarborough, chf engr.
Remarks: Refinery gases supplied by Standard Oil Co. of California.

ALLIED CHEMICAL & DYE CORP.
(National Aniline Division) 5
Buffalo, N. Y.
Hydrocarbon raw materials:
Kerosine fraction
White oil fraction
Products and output:
Alkyl aryl sulfonates (water soluble)
Alkyl aryl sulfonates (oil soluble)
Dodecylbenzene
Personnel: J. F. Daly, mgr; B. R. MacKinnon, supt; H. W. Busch, chf engr.

ALLIED CHEMICAL & DYE CORP.
(Nitrogen Division) 6
La Platte, Neb.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—75,000 ton/yr
Urea—110,000 ton/yr
Nitrogen solutions
Personnel: R. L. Riggs, mgr; V. A. Perringer, supt; I. H. Novikoff, chf engr.

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 139-149. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 360 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

ALLIED CHEMICAL & DYE CORP.
(Nitrogen Division) 7
South Point, Ohio
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—320,000 ton/yr
Urea—80,000 ton/yr
Methanol—53,500 ton/yr
Formaldehyde—42,500 ton/yr (100%)
Nitrogen solutions
High analysis mixed fertilizer
Urea-formaldehyde concentrate
Personnel: M. W. Butler, mgr; G. E. Brandon, Jr., supt; J. H. Critcher, chf engr.

ALLIED CHEMICAL & DYE CORP.
(Nitrogen Division) 8
Orange, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene oxide—12,000 ton/yr
Ethylene glycol—16,000 ton/yr
Ethanolamines
Diethylene glycol
Triethylene glycol
Personnel: E. L. Ray, mgr; H. Lanier, supt; J. E. Hollis, Jr., chf engr.

ALLIED CHEMICAL & DYE CORP.
(Nitrogen Division) 9
Hopewell, Va.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—400,000 ton/yr
Ammonia nitrate
Nitrogen solutions
Sodium nitrate
Nitrogen tetroxide
Personnel: F. A. Ernst, mgr; S. G. Mckenzie, supt; W. L. E. Dewling, chf engr.

ALLIED CHEMICAL & DYE CORP.
(Semet-Solvay Division) 10
Tonawanda, N. Y.
Hydrocarbon raw materials:
Ethylene (from fuel oil)
Fuel oil
Products and output:
Polyethylenes—20,000,000 lb/yr
Butadiene—8,000,000 lb/yr
Propylene—10,000,000 lb/yr
High melting polyethylene wax
Polyethylene resin pipe compound
Personnel: A. J. Koehne, supt; H. J. Andresen, chf engr.
Remarks: Crude light oils are recovered and refined at another location. Present polyethylene facilities represent a $10-million investment. Installing additional capacity for polyethylene resin pipe compound, to be available at the end of 1957.

ALLIED CHEMICAL & DYE CORP.
(Solvay Process Division) 11
Moundsville, W. Va.
Hydrocarbon raw materials:
Methane
Products and output:
Methyl chloride
Methylene chloride
Chloroform
Carbon tetrachloride
Hydrogen chloride
Total—11,500 ton/yr
Personnel: R. B. Lautner, mgr; C. D. Smith, supt.

ALOX CORP. 12
Niagara Falls, New York
Hydrocarbon raw materials:
Oxygenated petroleum hydrocarbons
Products and output:
Rust preventives, oil and cutting oil additives, total—12.5-million lb/yr
Personnel: C. A. Weltman, manager; E. F. Tiegerman, supt.
Remarks: Parent, Montgary Explorations Ltd, Toronto, Ont.

AMERICAN CYANAMID CO. 13
Fortier, La.
Approximate investment: $50,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia
Ammonium sulfate
Acetylene
Hydrocyanic acid
Acrylonitrile
Sulfuric acid
Personnel: C. F. Bonnet, mgr.
Remarks: Company started $39,000,000 program to double acrylonitrile capacity in April, 1956. Completion expected late 1957.

AMERICAN OIL CO. 14
El Dorado, Ark.
Hydrocarbon raw materials:
Propane-propylene
Butane-butylene
Products and output:
Propylene tetramer—3.8-million gal/yr
Polybutylene—2-million gal/yr
Trimer—350,000 gal/yr
Personnel: J. M. Brown, mgr; C. L. Parris, chf engr.
Remarks: Formerly Pan-Am Southern Corp. Parent, Standard Oil Co. (Ind.). Sales organization is Amoco Chemicals Corp.

AMERICAN OIL CO. 15
Destrehan, La.
Hydrocarbon raw materials:
Butenes
Products and output:
Polybutenes—250 b/cd
Personnel: H. A. Heiss, mgr.
Remarks: Formerly Pan-Am Southern Corp. Parent, Standard Oil Co. (Ind.). Amoco Chemicals Corp. is sales organization.

AMERICAN OIL CO. 16
Texas City, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Plasticizers
Polymers and resins
Benzene
Toluene
Xylene
Methyl mercaptan
Personnel: B. F. Babin, mgr.
Remarks: Parent, Standard Oil Co. (Ind.). Amoco Chemical Corp. is sales organization.

AMERICAN OIL CO. 17
Yorktown, Va.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfur—50 ton/day
Personnel: M. C. Hopkins, mgr.
Remarks: Completion due Nov. 1957.

AMERICAN SYNTHETIC RUBBER CORP. 18
Camp Ground Road, Louisville, Ky.
Approximate investment: $8,200,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
Synthetic rubber—68,500 long ton/yr
Personnel: H. W. Cable, VP-mfg; R. W. MacFarlane, prod supt; E. W. Zipfel, chf engr.
Remarks: Recent addition of 24,500 long ton/yr capacity cost $3,500,000; was completed May 1957.

AMOCO CHEMICALS CORP. 19
Joliet, Ill.
Approximate original investment: $10,000,000
Hydrocarbon raw materials:
Xylenes
Products and output:
Phthalic anhydride
Isophthalic acid
Terephthalic acid
Dimethyl terephthalate
Dimethyl isophthalate
Benzoic acid
Total chemicals—60-million lb/yr
Personnel: C. L. Parris, mgr.
Remarks: $10-million, 60-million lb/yr oxidation plant, using Scientific Design Co.-developed process. Building, for completion 1958. Parent, Standard Oil Co. (Ind.).

AMOCO CHEMICALS CORP. 20
Brownsville, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Acetaldehyde
Propionaldehyde
Methanol
Ethanol
Iso-propanol
N-propanol
Iso-butanol
Acetone
Methyl propyl ketone
Methyl ethyl ketone
Methyl butyl ketone
Acetic acid
Propionic acid
Total chemicals—180-million lb/yr
Personnel: L. L. Smith, mgr; G. F. Moore, supt; J. D. Wells, chf engr.
Remarks: Formerly Hildago Chemical Corp. Plant undergoing rehabilitation. Parent, Standard Oil Co. (Ind.).

AMOCO CHEMICALS CORP. 21
Texas City, Texas
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Aromatic solvents
Methyl mercaptan
Nonene
Hydrocarbon plasticizers
Petroleum resins
Drying oils
Personnel: J. D. Reed, plt mgr; O. W. Collier, supt; E. Schlesser, chf engr.
Remarks: Parent, Standard Oil Co. (Ind.) Formerly part of American Oil Co.

APACHE POWDER CO. 22
Curtiss, Arizona
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—30 ton/day
Remarks: Girdler & Co. designed, engineered and will start up $1-million, 30-ton/day ammonia plant, for completion end of 1957.

ATLANTIC REFINING CO., THE 23
Philadelphia, Penna.
Hydrocarbon raw materials:
Asphalt
Byproduct hydrogen from cat reformer
Petroleum fractions
Refinery gases
Solvent extracts
Products and output:
Alkybenzene
Ammonia
Aromatic solvents
Butylenes
Crude carbolates
Crude cresylic acid
Crude mercaptans
Diisobutylene
Dodecylbenzenesulfonic acid type of water-soluble alkyl aryl sulfones
Nonyl dodecylbenzene
Propane
Sulfonated petroleum aromatic compounds
Sulfuric acid
Synthetic detergents
Technical eicosane
Thermoplastic resin
Various solvents, plasticizers, organic acids, etc.
Personnel: D. T. Shaw, mgr.
Remarks: Increasing ammonia capacity from 100 ton/day to 165 ton/day, part of $11-million expansion program. Status, engineering.

ATLANTIC REFINING CO. 24
Atreco, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic detergents
Personnel: P. L. Robison, mgr.

ATLAS POWDER CO. 25
Location undecided
Approximate investment: $6,750,000
Hydrocarbon raw materials:
Petroleum hydrocarbons
Products and output:
Ammonia
Remarks: Plant still in planning stage. Certificate of necessity has expired, and no request for renewal is presently pending.

ATLAS PROCESSING CO. 26
Shreveport, La.
Approximate investment: $5,975,000
Hydrocarbon raw materials:
Naphtha from natural gas
Products and output:
Benzene—602 b/cd
Personnel: V. B. Chance, pres & mgr; C. S. Luce, supt; W. L. Hiller, chf engr.
Remarks: Plan UOP-designed Penex Isomerization unit. Construction to begin Sept. 1957, tentative completion date March 1958. Hudson Engineering Co, builder.

AURORA GASOLINE CO. 27
Detroit, Mich.
Approximate investment: $250,000
Hydrocarbon raw materials:
Refinery streams
Products and output:
Sulfur—9,900 ton/yr
Personnel: P. Blasco, supt; H. J. Oberding, chf engr.

B

BAKELITE CO. 28
Marietta, Ohio
Hydrocarbon raw materials:
Phenol
Products and output:
Styrene
Remarks: Raw materials include both petroleum and non-petroleum sources. Parent, Union Carbide Corp.

BARIUM REDUCTION CORP. 29
So. Charleston, W. Va.

Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon disulfide
Sodium sulphydrate
Personnel: L. Preisman, tech dir and genl mgr; C. F. Hobson, supt; E. W. Wick, chf engr.

THE BORDEN CO. (Chemical Division) **30**
Fayetteville, No. Car.
Hydrocarbon raw materials:
Methanol
Products and output:
Formaldehyde—36,000,000 lb/yr
Personnel: C. Fulp, mgr; I. Welborn, supt.
Remarks: In operation since 3-1-57

THE BORDEN CO. (Chemical Division) **31**
Kent, Wash.
Hydrocarbon raw materials:
Methanol
Products and output:
Formaldehyde—36-million lb/yr
Personnel: R. T. Hanson, mgr; B. Butler, chf engr.
Remarks: In operation since Feb, 1957

BRAY CHEMICAL CO. **32**
Los Angeles, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lubricating oil additives
Petroleum sulfonates—15-million lb/yr
Personnel: R. P. Schuster, mgr; C. N. Whitaker, chf engr.

BREA CHEMICALS, INC.
Brea, Calif.
Remarks: Merged with R. T. Collier Corp. by parent, Union Oil Co. of Calif., to form Collier Carbon & Chemical Co.

BREA CHEMICALS, INC.
Los Angeles County, Calif.
Remarks: Plans to build polyethylene plant jointly with Koppers have been cancelled.

BRIN CHEMICAL CORP.
Tulsa, Okla.
Remarks: Operations suspended

BRYTON CHEMICAL CO.
Remarks: Now Bryton Chemical Div. of Continental Oil Co.

C

CABOT CARBON CO. **33**
Franklin, La.
Hydrocarbon raw materials:
Petroleum residues
Natural gas
Products and output:
Carbon blacks—157-million lb/yr
Personnel: D. C. Paulsen, plt mgr; H. S. Ayres, plt supt.

CABOT CARBON CO. **34**
Ville Platte, La.
Hydrocarbon raw materials:
Petroleum residues
Natural gas
Products and output:
Furnace blacks—129-million lb/yr
Personnel: R. D. Gibson, plt mgr; R. T. Bowen, plt supt.

CABOT CARBON CO. **35**
Big Spring, Texas
Hydrocarbon raw materials:
Petroleum residues
Products and output:
Oil furnace blacks—67.3-million lb/yr
Personnel: A. R. Davenport, plt supt.

CABOT CARBON CO. **36**
Kermit, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks—28-million lb/yr
Personnel: B. F. Bulls, plt supt.

CABOT CARBON CO. **37**
Pampa, Texas
Hydrocarbon raw materials:
Natural gas
Petroleum residues
Products and output:
Furnace blacks—51-million lb/yr
Personnel: E. J. O'Brient, plt supt.

CABOT CARBON CO. **38**
Skellytown, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks for rubber, ink, and paint
Total—27-million lb/yr
Personnel: W. L. Marshall, plt mgr; J. M. Brown, plt supt.

CALCASIEU CHEMICAL CORP. **39**
Lake Charles, La.
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene oxide
Ethylene glycol—8-million gal/yr
Remarks: To be engineered and operated by Petroleum Chemicals, Inc. Lummus Co. will build the $11-million unit, using Shell Development Co.'s ethylene oxide process. Completion scheduled early 1958. Owners, Cities Service Co., Continental Oil Co., Sears Roebuck & Co., and Minerals Industries, Inc.

CALIFORNIA SPRAY CHEMICALS CORP. **40**
Richmond, Calif.
Hydrocarbon raw materials:
Petroleum bases
Natural and refinery gases
Products and output:
Aromatic solvents
Spray detergents
Emulsifiers
Summer & winter oil sprays
n-trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide
n-butyl,2,4-dichlorophenoxyacetate
Isopropyl,2,4-dichlorophenoxyacetate
2,4-Dichlorophenoxy-acetic acid, dimethylamine salt
Tetrahydrofurfuryl,2,4,5-trichlorophenoxy-acetate
Tetraethyl pyrophosphate
Ethylene glycol mono-oleate
Ammonia—300 ton/day
Nitric acid—250 ton/day
Ammonium Sulfate—200 ton/day
Ammonium Nitrate—175 ton/day
Fertilizer solutions—950 ton/day
Personnel: E. W. Cannon, VP.
Remarks: Parent, Standard Oil Co. of Calif.

CALUMET NITROGEN PRODUCTS CO. **41**
Hammond, Ind.
Approximate original investment: $9,000,000
Hydrocarbon raw materials:
Reformer off-gas
Products and output:
Anhydrous ammonia—109,500 ton/yr
Nitrogen solutions—36,500 ton/yr
Remarks: By-product hydrogen to be obtained from Standard Oil (Ind.) Whiting, Ind., and Sinclair East Chicago, Ind., refineries. Indiana Std to operate. New company is jointly owned (55% Indiana Std. & 45% Sinclair.) Plant scheduled for completion Aug. 1957.

CARBIDE AND CARBON CHEMICALS CO.
Now Union Carbide Chemicals Co.

CARBON BLACKS, INC. **42**
Rayville, La.
Approximate investment: $100,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—720,000 lb/yr
Personnel: J. H. Mann, Jr., pres; J. H. Mann, Sr., treas. & gen. mgr.

CARLISLE CHEMICAL WORKS, INC. **43**
Reading, Ohio
Hydrocarbon raw materials:
Petroleum fractions
Naphthenic acid
Products and output:
Lead napthenate
Lube additives (extreme pressure type)
Esters of petroleum derivatives
Personnel: K. L. Schanbacher, pres; W. R. Hawkins, supt; H. E. Klotz, chf engr.
Remarks: Parent, Cincinnati Milling Machine Co.

CELANESE CORP. OF AMERICA **44**
Bishop, Texas
Hydrocarbon raw materials:
Propane and butane

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 139-149. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 360 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

Products and output:
Methanol
n-Propanol
Formaldehyde
Paraformaldehyde
Acetaldehyde
Acetic acid
Acetone
Butylene glycol
Propylene oxide and glycol
Dipropylene glycol
Trioxane
Iso- and n-butanol
Iso-butyl, n-butyl, and n-propyl acetate
Methylal
Ethylene glycol diacetate
Personnel: J. F. Frick, mgr.
Remarks: Building new trimethylolpropane plant for completion late 1957. Arthur Bros. Co. constructor.

CELANESE CORP. OF AMERICA **45**
Pampa, Texas
Hydrocarbon raw materials:
Butane
Products and output:
Acetaldehyde
Acetic acid and anhydride
Vinyl acetate
Propionic and butyric acid
Methanol and solvents
Methyl ethyl ketone
Personnel: H. V. Wilks, mgr.
Remarks: Building 15-million lb/yr acrylate ester plant for completion late 1957. Farnsworth and Chambers Construction Co., contractor.

CELANESE CORP. OF AMERICA
Plastics Div. **46**
Houston, Texas
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Low press polyethylene, Fortiflex—40-million lb/yr
Personnel: B. E. Cash, mgr; S. T. Ross, supt; W. G. Hamm, chf engr.
Remarks: Operations started April 57.

CELANESE CORP. OF AMERICA **47**
Gallipolis Ferry, W. Va.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Tricresyl phosphate
Plasticizers
Functional fluids
Dialkyl phosphate
Phenyl dicresyl phosphate
Chlorinated phosphates
Pentaerythritol esters
Personnel: P. C. Pearson, mgr.
Remarks: Uses raw materials from Bishop and Pampa, Texas, plants, plus some coal-tar hydrocarbons.

CHEMOIL CORP. **48**
New Orleans, La.
Hydrocarbon raw materials:
Crude oils
Products and output:
Benzene
Toluene
Xylenes
Ethylene
Propylene
Personnel: J. R. Tusson, pres.
Remarks: Completion of refinery due Dec. 1959.

CHEMSTRAND CORP. **49**
Decatur, Ala.
Hydrocarbon raw materials:
Natural gas
Products and output:
Acrylic fiber, Acrilan
Personnel: Dr. K. Johnson, mgr.
Remarks: To increase Acrilan plant capacity to 45-million lb/yr for 1958 completion. Parents, Monsanto Chemical Co. & American Viscose Corp.

CHEMSTRAND CORP. **50**
Pensacola, Fla.
Hydrocarbon raw materials:
Natural gas
Cyclohexane
Products and output:
Nylon—88-million lb/yr
Personnel: F. G. Gronemeyer, mgr; R. T. Phelps, Jr., engrg supt; L. E. Dequine, Jr., asst mgr.
Remarks: To increase nylon capacity to 114-million lb/yr. Completion scheduled for 1958.

COLLIER CARBON & CHEMICAL CORP. **51**
Brea, Calif.

Approximate original investment: $18,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—86,000 ton/yr
Nitric acid (100% basis)—44,000 ton/yr
Ammonium nitrate—55,000 ton/yr
Ammonium phosphate—25,000 ton/yr
Dry ice and carbon dioxide—34,000 ton/yr
Personnel: R. S. Ogilvie, supt; M. G. Dalich, opers supt; H. E. Kinsella, supt maint engrg.
Remarks: Formerly Brea Chemicals, Inc. Merged with R. T. Collier Corp. by parent, Union Oil Co. of Calif.

COLLIER CARBON & CHEMICAL CORP. ... 52
Fresno, Calif.
Approximate original investment: $100,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonium phosphate—17,000 ton/yr
Remarks: Formerly Brea Chemicals, Inc. Merged with R. T. Collier Corp. by parent, Union Oil Co. of Calif.

COLUMBIA RIVER CHEMICALS, INC. ... 53
Attalia, Wash.
Approximate investment: $12,000,000
Hydrocarbon raw materials:
Bunker C fuel oil
Products and output:
Anhydrous ammonia—57,600 ton/yr
Ammonium sulfate—50,400 ton/yr
Urea—39,600 ton/yr
Remarks: Reported still in planning stage, though project is temporarily held in abeyance.

COLUMBIA-SOUTHERN CHEMICAL CORP. 54
Barberton, Ohio
Hydrocarbon raw materials:
Propylene
Acetylene
Products and output:
Perchloroethylene
Trichlorethylene
Personnel: W. S. Straub, mgr; W. Harris, oper supt; J. A. Hanlon, chf engr.
Remarks: Parent, Pittsburgh Plate Glass Co.

COLUMBIA-SOUTHERN CHEMICAL CORP. 55
Natrium, W. Va.
Hydrocarbon raw materials:
Hydrogen
Benzene
Products and output:
Anhydrous ammonia
Monochlorobenzene
Dichlorobenzene
Benzenehexachloride
Personnel: C. E. Wolf, mgr; J. A. Clapperton, oper supt; G. L. Cobb, chf engr.
Remarks: Parent, Pittsburgh Plate Glass Co.

COLUMBIAN CARBON CO. 56
El Dorado, Ark.
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—63-million lb/yr
Personnel: R. H. Cobb, supervisor

COLUMBIAN CARBON CO. 57
Hickok, Kans.
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—32.2-million lb/yr
Personnel: J. W. Buchanan, supervisor

COLUMBIAN CARBON CO. 58
Eola, La.
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—45.5-million lb/yr
Personnel: A. L. Wempe, supervisor

COLUMBIAN CARBON CO. 59
Franklin, La.
Hydrocarbon raw materials:
Natural gas
Products and output:
Furnace black—52.5-million lb/yr
Personnel: J. S. Norris, Jr., supervisor

COLUMBIAN CARBON CO. 60
Hancock, La.
Remarks: An experimental pilot plant, operating on atural gas to produce furnace blacks.

COLUMBIAN CARBON CO. 61
Eunice, N. Mex.
Hydrocarbon raw materials:
Natural and casinghead gas
Products and output:
Channel black—24.5-million lb/yr
Personnel: C. E. Thompson, supervisor

COLUMBIAN CARBON CO. 62
Coltexo, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel black—6.55-million lb/yr
Personnel: Bernard Johnson, supervisor, main plant; Howard Johnson, supervisor plant 2.

COLUMBIAN CARBON CO. 63
Conroe, Texas
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—68.6-million lb/yr
Personnel: C. C. May, supervisor

COLUMBIAN CARBON CO. 64
Corpus Christi, Texas
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Channel black—11.3-million lb/yr
Personnel: J. C. Aulds, supervisor.

COLUMBIAN CARBON CO. 65
Fortune, Texas
Remarks: Furnace black plant, idle since March 25, 1955, on standby.

COLUMBIAN CARBON CO.
Kingsmill, Texas
Remarks: Channel black plant, idle since July, 1954, has been dismantled.

COLUMBIAN CARBON CO. 66
Lefors, Texas
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Channel black—26-million lb/yr
Personnel: R. M. Harvey, supervisor.

COLUMBIAN CARBON CO. 67
Seagraves, Texas
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Furnace black—53.9-million lb/yr
Personnel: R. Fowler, supervisor.

COLUMBIAN CARBON CO. 68
Seminole, Texas
Hydrocarbon raw materials:
Natural gas and/or petroleum fractions
Products and output:
Channel black—27-million lb/yr
Sulfur—15.4 ton/yr
Personnel: J. E. Earhart, supervisor.

COLUMBIAN CARBON CO.
Sunray, Texas
Remarks: Channel black plant, idle since Aug. 1953, has been dismantled.

COLUMBIAN CARBON CO. 69
Sweeney, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—867,600 lb/yr
Personnel: E. Johnson, supervisor

COMMERCIAL SOLVENTS CORP. 70
Peoria, Ill.
Hydrocarbon raw materials:
Natural gas
Products and output:
Nitroparaffins
Personnel: T. M. Walton, mgr.

COMMERCIAL SOLVENTS CORP. 71
Sterlington, La.
Approximate investment: $45,000,000
Hydrocarbon raw materials:
Natural gas and propane
Products and output:
Ammonia—135,000 ton/yr
Methanol
Ammonium nitrate solutions
Solid ammonium nitrate fertilizer
Nitroparaffin—10-million lb/yr
Personnel: J. E. Wheeler, genl mgr prod, petrochemicals division.
Remarks: $10-million program to increase production of methanol and petrochemicals will be completed in 1957.

CONSOLIDATED CHEMICAL INDUSTRIES (Div., Stauffer Chemical Co.) 72
Baton Rouge, La.
Hydrocarbon raw materials:
Hydrogen sulfide
Alkylation sludge
Products and output:
Sulfuric acid
Sulfur
Personnel: W. J. Daspit, mgr.

CONSOLIDATED CHEMICAL INDUSTRIES (Div., Stauffer Chemical Co.) 73
Baytown, Texas
Hydrocarbon raw materials:
Hydrogen sulfide
Alkylation sludge
Products and output:
Sulfuric acid
Sulfur
Personnel: Z. L. Evans, mgr.
Remarks: Sulfur recovery capacity being increased 100 ton/day.
Unit being built by Ralph M. Parsons Co. for completion early 1958.

CONSOLIDATED CHEMICAL INDUSTRIES (Div., Stauffer Chemical Co.) 74
Houston, Texas
Hydrocarbon raw materials:
Alkylation sludge
Products and output:
Sulfuric acid
Sulfur
Personnel: O. D. Massey, mgr.

CONTINENTAL BLACKS, INC. 75
Westlake, La.
Hydrocarbon raw materials:
Refractory refinery cycle stock
Products and output:
Carbon black—40-million lb/yr.
Personnel: W. Fergus, mgr.

CONTINENTAL BLACKS, INC. 76
Ponca City, Okla.
Hydrocarbon raw materials:
Refractory refinery cycle stock
Products and output:
Carbon black—60-million lb/yr
Personnel: F. Forbes, mgr.

CONTINENTAL CARBON CO. 77
Eunice, New Mex.
Hydrocarbon raw materials:
Natural gas
Products and output:
SRF black—25-million lb/yr
Channel black
Personnel: F. W. Keith, mgr.

CONTINENTAL CARBON CO. 78
Sunray, Texas
Hydrocarbon raw materials:
Dry natural gas
Refractory refinery cycle stock
Products and output:
Carbon blacks
Personnel: Norman Higgins, mgr

CONTINENTAL OIL CO. 79
Chicago, Ill.
Hydrocarbon raw materials:
Dodecylbenzene
Products and output:
Water soluble sulfonates
Oil fracturing compounds
Personnel: T. J. Karolenko, supt.

CONTINENTAL OIL CO. 80
Lake Charles, La.
Approximate original investment: $2,700,000
Hydrocarbon raw materials:
Propylene
Products and output:
Benzene
Toluene
Xylene
Dodecene
Propylene tetramer
Pentadecene
Personnel: J. M. Jones, mgr.
Remarks: Dodecene and benzene are delivered to the Continental petrochemical plant at Baltimore, Md., where dodecylbenzene is produced for the detergent industry.

CONTINENTAL OIL CO. 81
Baltimore, Md.
Hydrocarbon raw materials:
Benzene
Dodecene
Products and output:
Synthetic detergent base stock
Personnel: W. O. Miller, supt.

CONTINENTAL OIL CO. 82
Billings, Mont.
Hydrocarbon raw materials:
Hydrogen sulfide
Products and output:
Sulfur
Personnel: J. A. Ramsey, supt; J. L. Bruce, chf engr.

CONTINENTAL OIL CO. 83
Ponca City, Okla.
Approximate investment: $7,500,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene and other aromatic mixtures (as reformate)—3850 b/d
Toluene
Propylene tetramer
Personnel: C. D. Hull, mgr.

CONTINENTAL OIL CO. Bryton Chemical Div. 84
Trainer, Penna.
Hydrocarbon raw materials:
Petroleum fractions

Products and output:
Sodium sulfonates
Calcium sulfonates
Barium sulfonates
Ammonium sulfonates
Personnel: E. W. Carlson, mgr; C. H. Blouch, supt.

CONTINENTAL OIL CO. 85
(**Sherwood Refining Div.**)
Gretna, La.
Hydrocarbon raw materials:
Petroleum fractions
Lube oil stocks
Raw petrolatums
Products and output:
White oils
Natural sulfonates
Refined petrolatums
Personnel: K. R. Gerhart, supt.

CONTINENTAL OIL CO.
(**Sherwood Refining Div.**)
Korns City, Penna.
Remarks: Closed down July 1, 1957. Plant to be sold or dismantled.

COOPERATIVE FARM CHEMICALS ASSN. 86
Lawrence, Kans.
Approximate investment: $18,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—13,200 ton/yr
Ammonium nitrate—83,000 ton /yr
Nitrogen solutions—13,200 ton/yr
Personnel: R. R. Zurbuchen, mgr; C. C. Chaffee, supt; A. D. Fornelli, chf engr.

COPOLYMER RUBBER & CHEMICAL CORP. 87
Baton Rouge, La.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Butylene
Styrene
Products and output:
Butadiene—35,000 short ton/yr
GR-S synthetic rubber—68,800 long ton/yr
Personnel: T. B. Crowell, VP & mgr; C. M. McKay, supt; H. C. Henry, chf engr.
Remarks: GRS rubber capacity increased from 49,000 to 68,800 ton/yr; July '57.

COSDEN PETROLEUM CORP. 88
Big Spring, Texas
Approximate investment: $9,000,000
Hydrocarbon raw materials:
Aromatic naphtha
Depentanized straight run gasoline
LPG fraction
Cycle stock
Mixed xylenes
Products and output:
Benzene—2.5 million gal/yr
Toluene—7-million gal/yr
Xylene—9-million gal/yr
Polybutene—1-million gal/yr
Styrene—20-million lb/yr
Ethylbenzene—22-million lb/yr
Personnel: D. M. Krausse, mgr; G. Grimes, supt; E. B. McCormick, chf engr.
Remarks: 20-million lb/yr polystyrene capacity under construction by Blaw-Knox, engineer-contractor. 40-million lb/yr dodecylbenzene planned, licensed by UOP. New styrene recovery plant on stream Feb. 1957.

CROWN CENTRAL PETROLEUM CORP. 89
Houston (Pasadena), Texas
Hydrocarbon raw materials:
Refinery gas streams
Products and output:
Ethylene
Propylene
Personnel: K. W. Shimeall, VP Southwest Opers; R. T. Colquette, VP, rfg; R. S. Myers, supt; H. E. Fisher, chf engr.
Remarks: Petrochemical products extracted by Shell Chemical—propanes, butanes.

D

DEERE & CO. 90
(**Grand River Chemical Division**)
Pryor, Oklahoma
Approximate investment: $18,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—65,800 ton/yr
Urea—90,000 ton/yr
Personnel: W. W. Yeandle, genl mgr; J. T. Purnell, supt; J. E. Dew, chf engr; R. B. Ady, tech. mgr.

DELHI TAYLOR OIL CORP. 91
Corpus Christi, Texas
Hydrocarbon raw materials:
Crude oil and distillate
Products and output:
Benzene—1050 b/d
Toluene—700 b/d
Personnel: F. A. Reneau, supt; H. F. Warnke, chf engr.
Remarks: Udex unit on stream July 1, 57. Design capacity 7000 b/d

DIAMOND ALKALI CO. 92
(**Chlorinated Products Division**)
Newark, N. J.
Hydrocarbon raw materials:
Benzene
Products and output:
Hexachlorobenzene
Chloral
Miticides
2, 4-D
2, 4, 5-T
DDT
Benzene sulfonyl chloride
Dichlorphenol
Trichlorphenol
Organic intermediates
Muriatic acid
Personnel: John Burton, mgr.

DIAMOND ALKALI CO. 93
(**Chlorinated Products Division**)
Painesville, Ohio
Hydrocarbon raw materials:
Paraffin wax
Products and output:
Chlorinated paraffin, liquid and resinous
Carbon tetrachloride
Anhydrous hydrogen chloride
Personnel: R. C. Rahn, mgr; C. H. Shie, chf engr; C. Ashman, maint supt.

DIAMOND ALKALI CO. 94
(**Chlorinated Products Division**)
Deer Park, Houston, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Vinyl chloride
Polyvinyl chloride
Ethylene dichloride
Perchlorethylene
Paraffin solvent
Anhydrous hydrogen chloride
Personnel: W. J. Butler, mgr.
Remarks: Plan 50-million lb/yr vinyl chloride unit for early 1958, design & engineering by Scientific Design Co., Inc., and construction by Brown & Root, Inc. Also plan "multimillion-dollar" acetylene from natural gas unit, with construction to start probably early '58.

DIAMOND ALKALI CO. 95
(**Chlorinated Products Division**)
Greens Bayou, Houston, Texas
Hydrocarbon raw materials:
Benzene
Products and output:
Benzene hexachloride
DDT
Hexachlorobutadiene
Hexachloroethane
Muriatic acid
Personnel: R. J. Koll, mgr; L. W. Hindes, supt; R. Seimoneit, chf engr.
Remarks: Increasing capacity of DDT plant.

DIAMOND ALKALI CO. 96
(**Chlorinated Products Division**)
Belle, W. Va.
Hydrocarbon raw materials:
Natural gas
Products and output:
Methyl chloride
Methylene chloride
Chloroform
Muriatic acid
Personnel: Ralph Martz, mgr.

DOW CHEMICAL CO. 97
Pittsburg, Calif.
Hydrocarbon raw materials:
Natural gas
Styrene
Butadiene
Products and output:
Methylene chloride
Methyl chloride
Chloroform
Carbon tetrachloride
Perchloroethylene
Styrene-butadiene latex
Personnel: L. O. Simenson, prod mgr.

DOW CHEMICAL CO. 98
Torrance, Calif.
Hydrocarbon raw materials:
Styrene from ethylene
Products and output:
Expanded polystyrene—Styrofoam
Polystyrene—Styron
Personnel: D. W. Ryan, mgr.

DOW CHEMICAL CO. 99
Allyn's Point, Conn.
Hydrocarbon raw materials:
Styrene from ethylene
Products and output:
Expanded polystyrene—Styrofoam
Polystyrene—Styron
Personnel: K. E. Stober, mgr.

DOW CHEMICAL CO. 100
Baton Rouge—Plaquemine area, La.
Hydrocarbon raw materials:
Liquid petroleum gas
Products and output:
Ethylene
Propylene
Glycols
Vinyl chloride
Other chlorinated hydrocarbons and related products
Personnel: J. R. Stein, mgr.
Remarks: Completion of $50-million plant scheduled in 1958.

DOW CHEMICAL CO. 101
Midland, Mich.
Hydrocarbon raw materials:
Crude oil
Fuel oil
Ethylene
Propylene
Benzene
Styrene from ethylene
Products and output:
Styrene
Butadiene
Alpha methyl styrene
Ethylbenzene
Ethyl chlorice
Ethylene dibromide
Polystyrene—Styrofoam
Polystyrene—Styron
Diethyl benzene
Divinyl benzene
Ethylene dichloride
Ethylene oxide
Mono-, di-, and tri-ethanolamine
Ethylene diamine
Isopropyl benzene
Isopropyl chloride
Propylene glycol
Propylene oxide
Propylene dichloride
Isopropanolamines
Polyglycols
Polyglycol ethers
Polyvinylidene chloride
Ethyl cellulose
Methyl cellulose
Polyvinyl chloride
Vinyl toluene
Personnel: W. H. Schuette, genl mgr.

DOW CHEMICAL CO. (Riverside Plt.) 102
Pevely, Mo.
Hydrocarbon raw materials:
Styrene from ethylene
Products and output:
Polystyrene—Styron and Styrofoam
Personnel: R. E. Reinker, mgr.

DOW CHEMICAL CO. (Hanging Rock Plt.) 103
Ironton, Ohio
Hydrocarbon raw materials:
Styrene from ethylene
Products and output:
Polystyrene
Personnel: M. H. Weymouth, mgr.

DOW CHEMICAL CO. (**Texas Division**) 104
Freeport and Velasco, Texas
Hydrocarbon raw materials:
LPG
Natural gas
Butadiene
Methane (natural gas)
Metane (natural gas)
Ethylene and propylene

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 139-149. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 360 petrochemicals

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Benzene
Products and output:
Styrene
Methyl chloride
Ethyl chloride
Ethylene dichloride
Vinyl chloride
Carbon tetrachloride
Chloroform
Ethylene glycol
Diethylene glycol
Triethylene glycol
Tetraethylene glycol
Propylene glycol
Dipropylene glycol
Perchloroethylene
Trichloroethylene
Dichlorethyl ether
Dichlorisopropyl ether
Ethylene oxide
Propylene oxide
Latex
Methyl chloroform
Methylene chloride
Polyglycols
Propylene dichloride
Styrene oxide
Toluene
Vinylidene chloride
Butadiene
Glycerine
Polyethylene
Methylacetylene
Epichlorhydrin
Ethylene diamine
Diethylenetriamine
Personnel: A. P. Beutel, genl mgr.
Remarks: Second glycerine plant under construction to double present capacity by March 1958. Additional ethylene glycol, chlorine, acetylene, ethanolamines and styrene facilities also under construction.

E. I. DU PONT DE NEMOURS & CO., INC. 105
Antioch, Calif.
Products and output:
Tetraethyl lead
Ethyl chloride
Freon 11 Trichloromonofluoromethane
Freon 12 Dichlorodifluoromethane refrigerants
Remarks: Completion scheduled for early 1957. Sodium and chlorinated solvents plans at Antioch cancelled.

E. I. DU PONT DE NEMOURS & CO., INC. 106
Laplace, La.
Remarks: 600 acres purchased 27 miles N of New Orleans as expansion site for Polychemicals Dept.

E. I. DU PONT DE NEMOURS & CO., INC. 107
Circleville, Ohio
Products and output:
Polyester film Mylar
Personnel: E. F. Ridlon, mgr.
Remarks: Plant expansion now in progress to increase capacity by 50%. New facilities to be ready for operation by spring of 1958.

E. I. DU PONT DE NEMOURS & CO., INC. 108
Memphis, Tenn.
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen cyanide
Sodium cyanide
Personnel: T. D. Bell, mgr.

E. I. DU PONT DE NEMOURS & CO., INC. 109
Beaumont, Texas
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Methanol mercaptan
Products and output:
Methionine
Chlorosulfonated polyethylene
Personnel: H. C. Bailey, mgr.
Remarks: New chlorosulfonated polyethylene unit completed June, 1957.

E. I. DU PONT DE NEMOURS & CO., INC. 110
La Porte, Texas
Hydrocarbon raw materials:
Methanol
Products and output:
Methylamines
Dimethyl formamide
Carbamate fungicides
Personnel: T. T. Chase, mgr.

E. I. DU PONT DE NEMOURS & CO., INC. 111
Orange, Texas
Hydrocarbon raw materials:
Natural gas
Propane
Ethylene
Benzene
Cyclohexane
Products and output:
Nylon intermediates (adipic acid, hexamethylene diamine)
Methanol
Polyethylene 100-million lb/yr
Personnel: D. B. Campbell, mgr.
Remarks: Increasing capacity of polyethylene & modernizing adipic acid facilities.

E. I. DU PONT DE NEMOURS & CO., INC. 112
Victoria, Texas
Hydrocarbon raw materials:
Natural gas
Butadiene
Products and output:
Adiponitrile
Personnel: M. T. Shattuck, mgr.
Remarks: Increasing capacity of adiponitrile.

E. I. DU PONT DE NEMOURS & CO., INC. 113
Waynesboro, Va.
Products and output:
Acrylic staple, Orlon—40-million lb/yr
Remarks: Building. Startup for early 1958.

E. I. DU PONT DE NEMOURS & CO., INC. 114
Belle, W. Va.
Products and output:
Adipic acid
Hexamethylene diamine
Remarks: Replacing coal with natural gas as raw material for 650 ton/day ammonia plant and nylon manufacture. Overall conversion to be completed 1959.

D-X SUNRAY OIL CO. 115
Duncan, Okla.
Approximate investment: $500,000
Hydrocarbon raw materials:
Petroleum fractions
Propylene
Products and output:
Propylene tetramer—160,000 bbl/yr
Personnel: R. L. Johnson, mgr; R. C. Underwood, supt; R. J. Riggs, chf engr.
Remarks: Parent, Sunray Mid-Continent Oil Co.

E

EASTERN STATES CHEMICAL CORP. 116
Houston, Texas
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Petroleum Naphthas
Products and output:
Benzene 2°—75,000 bbl/yr
Propane—255,000 bbl/yr
n-Butane—325,000 bbl/yr
Isobutane
Isopentane—220,000 bbl/yr
Personnel: H. M. Martin, mgr; J. J. Carrigan, supt; W. J. McBride, chf engr.
Remarks: Parent, Eastern States Petroleum Co., Inc.

THOMAS A. EDISON INDUSTRIES (Div., McGraw-Edison Co.) 117
Bloomfield, N.J.
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen
Remarks: Hydrogen is produced by a Girdler "Hygirtol" catalytic steam-reforming unit. Hydrogen is not sold but used as a raw material in iron purification.

EL PASO NATURAL GAS CO. 118
Farmington, N. Mex.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—12,600 ton/yr
Remarks: Company took over former plant of Imperial Sulfur and Acid Co. Sulfur operations shut down temporarily.

ESCAMBIA CHEMICAL CORP. 119
Pensacola, Fla.
Approximate investment: $30,000,000
Hydrocarbon raw materials:
Natural gas
Vinyl chloride monomer
Products and output:
Anhydrous ammonia—72,000 ton/yr
Ammonium nitrate solutions, Bay-Sol—110,000 ton/yr
Ammonium nitrate prills, Ammo-Nite—110,000 ton/yr
Nitric acid—80,000 ton/yr
Polyvinyl chloride resins—30-million lb/yr
Personnel: R. U. Haslanger, Pres; A. E. New, prod tech dir; R. M. Brown, plt mgr; D. J. Stark, VP and prod mgr.
Remarks: 20-mill-on gal/yr Methanol plant planned, for 1958 completion. Engineer-contractor, Chemical Construction and Badger.

ESSO STANDARD OIL CO. 120
Baton Rouge, La.
Hydrocarbon raw materials:
Natural gas
Petroleum gas and liquid fractions
Products and output:
Acetone
Ethyl alcohol
Isopropyl alcohol
Iso-octyl alcohol
Decyl alcohol
Tridecyl alcohol
Ethyl ether
Isopropyl ether
Isobutylene
Tetrapropylene
Tripropylene
Butadiene
Isoprene
Dicyclopentadiene
Benzene
Petroleum resins
Aromatic tars
Butyl rubber—47,000 long ton/yr
Propane
Propylene
Personnel: H. J. Voorhies, genl mgr.
Remarks: New ethylene unit is under construction.

ESSO STANDARD OIL CO. 121
Bayonne, N. J.
Products and output:
Naphthenic acid
Lube oil additives
Personnel: D. F. Edwards, mgr.

ESSO STANDARD OIL CO. 122
Linden, N. J.
Hydrocarbon raw materials:
Petroleum gases and liquid fractions
Products and output:
Isopropyl alcohol
Secondary butyl alcohol
Acetone
Ethylene
Methyl ethyl ketone
Isopropyl acetate
Isopropyl ether
Secondary butyl acetate
Isobutylene
Polyisobutylene
Lube oil additives
Naphthenic acids
Personnel: G. R. Murrell, mgr.
Remarks: A new ethylene unit is scheduled for completion in 1957.

ETHYL CORP. 123
Baton Rouge, La.
Hydrocarbon raw materials:
Ethane
Ethylene
Products and output:
Ethyl chloride
Ethylene dichloride
Tetraethyl lead
Personnel: W. F. Armstrong, resident mgr; J. J. Bergin, asst resident mgr; A. C. Burdick, chf engr.
Remarks: Plan vinyl chloride-from-ethylene plant, by Catalytic Construction Co., for late 57.

ETHYL CORP. 124
Houston, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethyl chloride
Ethylene dichloride
Anti-knock compound
Personnel: M. C. Hudgins, mgr; L. L. Davis, oper supt; R. E. Hodgkinson, chf engr.

ETHYL-DOW CHEMICAL CO. 125
Freeport, Texas
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene dibromide
Personnel: V. A. Thorpe, plt mgr.
Remarks: Increasing ethylene dibromide capacity 20% for fall 1957.

F

FIRESTONE PLASTICS CO. 126
Pottstown, Penna.
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Polybutadiene-acrylinotrile type acyclic elastomers
Polybutadiene-styrene type acyclic elastomers
Personnel: W. D. Handley, mgr.

FIRESTONE TIRE & RUBBER CO. (Synthetic Rubber and Latex Div.) 127
Lake Charles, La.
Approximate investment: $12,000,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:

FR-S synthetic rubber (butadiene-styrene type)—190,000 long ton/yr
Personnel: W. H. Cain, mgr; C. V. Dille, supt; C. R. McBride, chf eng.

FIRESTONE TIRE & RUBBER CO. (Synthetic Rubber and Latex Div.) 128
Akron, Ohio
Approximate investment: $2,350,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S synthetic rubber—40,000 long ton/yr
Synthetic latex (butadiene/styrene type)
Personnel: R. J. Easton, supt; C. J. Weber, chf engr.

FIRESTONE TIRE & RUBBER CO. (Synthetic Rubber and Latex Div.) 129
Orange, Texas
Hydrocarbon raw materials:
Butane
Products and output:
Butadiene—40,000 short ton/yr
Personnel: W. A. Wilson, mgr; C. C. Ferguson, supt; E. A. Lastrapes, chf engr.
Remarks: In operation since June, 1957. Styrene plans at Orange cancelled.

FOOD MACHINERY AND CHEMICAL CORP. FMC Organic Chemicals Division 130
Ohio-Apex, Nitro, W. Va.
Hydrocarbon raw materials:
Cresylic acid
Products and output:
Tricesyl phosphate
Dioctyl phthalate plasticizer
Diallyl phthalate prepolymer plasticizer
Personnel: B. S. Taylor, mgr; B. E. Gewin, supt; A. H. Adler, chf engr.

FOSTER GRANT CO., INC. 131
Baton Rouge, La.
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Ethylene
Benzene
Products and output:
Styrene monomer—60-million lb/yr.
Personnel: F. D. Mayfield, mgr.
Remarks: Expansion program underway. Plant gets raw materials from Esso Standard Oil Co.'s Baton Rouge, La. refinery.

FREEPORT SULPHUR CO. 132
Westville, N. J.
Approximate investment: $550,000
Hydrocarbon raw materials:
Refinery gas
Products and output:
Sulphur—12,775 long ton/yr
Personnel: J. K. Laberteaux, supt.

FRONTIER OIL REFINING CO. Div., Ashland Oil & Refining Co. 133
Tonawanda (near Buffalo) N. Y.
Approximate investment: $3,250,000
Hydrocarbon raw materials:
Cat reformate
Products and output:
Benzene—4.5-million gal/yr
Toluene, Xylenes, Others—12-million gal/yr
Personnel: R. E. Yancey, mgr (Ashland); M. C. Sumpter, supt (Frontier); G. S. Litton, chf engr. (Ashland).
Remarks: Startup scheduled for early 58.

G

GENERAL ANILINE & FILM CORP. 134
Linden, N. J.
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene oxide—60-million lb/yr
Ethylene glycol—35-million lb/yr
Remarks: Scientific Design Co., Inc. has design and engrg. contract. Esso Std. Oil Co. will supply ethylene. Completion late 1957.

GENERAL PETROLEUM CORP. 135
Torrance, Calif.
Hydrocarbon raw materials:
Refinery wastes
Products and output:
Ammonium sulfate—10 ton/day
Personnel: A. E. Thompson, mgr.
Remarks: Ammonium sulfate made in small volume as a by-product of anti-air pollution facilities. Parent, Socony Mobil Oil Co., Inc.

GENERAL TIRE & RUBBER CO. 136
Ashtabula, Ohio
Approximate investment: $7,500,000
Hydrocarbon raw materials:
Vinyl chloride
Products and output:
Polyvinyl chloride—36,000,000 lb/yr
Personnel: P. J. Wallace, mgr.
Remarks: 50% expansion of polyvinyl chloride, started late 1956, now in operation.

GENERAL TIRE & RUBBER CO. 137
Mogadore, Ohio
Hydrocarbon raw materials:
Styrene
Butadiene
Products and output:
Polyesters
Styrene resins
Vinylpyridine type acyclic elastomers
Rubber base paint latex
Personnel: J. A. Kleinhans, mgr; W. C. Martin, facilities.
Remarks: Expansion underway in styrene resin prod supt; R. W. Laundrie, tech supt.

GENERAL TIRE & RUBBER CO. 138
Odessa, Texas
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
S-type synthetic rubber—45,000 ton/yr
Personnel: J. A. Pollock, mgr; J. L. Bailey, supt.
Remarks: Completion expected Oct. 1, 1957. Cost to be $10-million for GR-S facilities only. Contractor, H. K. Ferguson Co.

GEORGIA-CAROLINA OIL CO. 139
Macon, Georgia
Personnel: R. W. Jones, Pres; R. W. Gober, mgr; H. E. Chapman, supt.
Remarks: Chemical plant affiliate: Triangle Chemical Co., Macon, Georgia, manufacturers of agricultural chemicals, wood preservers.

B. F. GOODRICH CHEMICAL CO. 140
Louisville, Ky.
Hydrocarbon raw materials:
Butadiene
Styrene
Acrylonitrile
Products and output:
Nitrile type synthetic rubber
Personnel: J. L. Nelson, mgr.

B. F. GOODRICH CHEMICAL CO. 141
Akron, Ohio
Hydrocarbon raw materials:
Butadiene
Styrene
Acrylonitrile
Products and output:
Nitrile type synthetic rubber
Personnel: C. B. Cooper, mgr.

GOODRICH-GULF CHEMICALS, INC. 142
Avon Lake, Ohio
Approximate investment: $1,000,000
Products and output:
Synthetic rubber
Remarks: Pilot plant only. In operation since Nov. 1956. Parents, B. F. Goodrich Co. & Gulf Oil Corp.

GOODRICH-GULF CHEMICALS, INC.
Orange, Texas
Remarks: Styrene plant plans here cancelled.

GOODRICH-GULF CHEMICALS, INC. 143
Port Neches, Texas
Approximate investment: $13,000,000
Hydrocarbon raw materials:
Butadiene and styrene
Products and output:
"Ameripol" rubber (S-type)—100,000 ton/yr
Personnel: W. R. Bateman, plt mgr; E. E. Mitchell, prod mgr; F. V. Morrison, plt engr; B. C. Pryor, tech mgr.
Remarks: Parents, B. F. Goodrich Co. & Gulf Oil Corp.

GOODRICH-GULF CHEMICALS, INC. 144
Institute, W. Va.
Hydrocarbon raw materials:
Butadiene
Styrene

Who Makes What Petrochemicals

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. . . plus descriptions of 360 petrochemicals

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Products and output:
Synthetic rubber
Personnel: F. C. Hands, mgr; E. F. Barker, chf engr; John Haas, prod mgr.
Remarks: The three production lines purchased from the government had rated capacity of 122,000 long ton/yr. One line, about 1/3 capacity, now operating. $2-million conversion of second line, planned to make Ameripol cold rubber, for early 1958 completion, will increase capacity slightly. Engr-contr, The Girdler Corp. Parent companies are B. F. Goodrich Co. and Gulf Oil Corp.

GOODYEAR SYNTHETIC RUBBER CORP. 145
Akron, Ohio
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S synthetic rubber—42,200 ton/yr
Personnel: R. C. Stell, mgr.
Remarks: Increased capacity of Copolymer by 27,000 ton/yr. Cost was $2.5-million; engineering by Staff; contractor was Carmichael; completion was June 1957. Parent, Goodyear Tire & Rubber Co.

GOODYEAR SYNTHETIC RUBBER CORP. 146
Houston, Texas
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S rubber—137,500 ton/yr
Personnel: B. A. Rosinski, genl mgr; J. C. Blackwell (tech supt.
Remarks: Increased capacity of copolymer by 70,000 ton/yr. Cost $10-million; engineering by Blaw-Knox; contractor is Tellepsen; completion was March 1957. A later project will bring capacity to 220,000 ton/yr.
Parent, Goodyear Tire & Rubber Co.

GOODYEAR TIRE & RUBBER CO. (Chemical division) 147
Akron, Ohio
Approximate investment: $5,250,000
Hydrocarbon raw materials:
Butadiene
Acrylonitrile
Styrene
Products and output:
Butadiene-acrylonitrile rubbers
High styrene resins
Personnel: F. R. Thies, genl mgr; J. C. Blackwell, tech supt.

GOODYEAR TIRE & RUBBER CO. 148
Niagara Falls, N. Y.
Hydrocarbon raw materials:
Acetylene
Products and output:
Polyvinyl chloride resins
Vinyl chloride copolymer dispersion resin
Vinyl chloride copolymer latex
Personnel: E. H. Manchester, mgr; R. H. Evans, chf engr.
Remarks: Was Pathfinder Chemical Co. Taken into parent, Goodyear Tire & Rubber Co., on Jan. 1, 1957.

W. R. GRACE & CO. 149
Baton Rouge, La.
Approximate investment: $18,000,000
Products and output:
Polyethylene—50-million lb/yr
Remarks: Fluor Corp. has construction contract for Phillips licensed process. Completion scheduled third quarter 1957.

W. R. GRACE & CO. 150
Acton, Mass.
Hydrocarbon raw materials:
Butadiene and styrene
Products and output:
Co-polymers—4-million lb/yr

GRACE CHEMICAL CO. (Div. W. R. Grace & Co.) 151
Woodstock, Tenn.
Approximate investment: $20,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—100,000 ton/yr
Urea—150 ton/day
Personnel: J. G. Carriere, mgr.

GREAT NORTHERN OIL CO. 152
Pine Bend, Minn.
Products and output:
Sulfur
Personnel: A. S. Gilliam, mgr; C. W. Gilmore, chf proc engr.

GREAT SOUTHERN CHEMICAL CORP. 153
Corpus Christi, Texas

Hydrocarbon raw materials:
Distillate gasoline
Products and output:
Benzene—7.25-million gal/yr
Toluene—13-million gal/yr
Xylenes—4.2-million gal/yr
Personnel: L. K. Grove, supt.

GULF OIL CORP. 154
Philadelphia, Penna.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Propylene
Sulfur—50,000 ton/yr
Personnel: J. O. Timms, genl mgr.

GULF OIL CORP. 155
Crane County, Texas (Waddell Plant)
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—7,000 ton/yr
Personnel: John Sherman, mgr.

GULF OIL CORPORATION 156
Port Arthur, Texas
Hydrocarbon raw materials:
Refinery gases
Heptane
Propylene
Sulfuric acid sludge
Products and output:
Ethylene—400-million lb/yr
Sulfur—120 ton/day
Isoctyl alcohol—9-million lb/yr
Propylene
Propylene polymers
Petroleum coke (sludge acid coke)
Butylenes
Aromatic distillates (ethylene coproduct)
Personnel: R. F. Faulkner, genl mgr.
Remarks: Sulfur capacity was increased during 1957 and 4 new sludge decomposing units put into operation. 30-million Benzene-toluene plant planned, with construction to start in 1957, completion for 1958.

H

HANCOCK CHEMICAL CO. 157
Wilmington, Calif.
Approximate investment: $3,500,000
Hydrocarbon raw materials:
Refinery hydrogen sulfide
Products and output:
Sulfur—200 ton/day
Personnel: G. E. Smalley, mgr.
Remarks: Raw gas comes from General Petroleum, Richfield, and The Texas Co. Two 65 ton/day sulfur recovery plants went on stream Sept., 1956.

HANCOCK OIL CO. 158
Long Beach, Calif.
Approximate investment: $350,000
Hydrocarbon raw materials:
Hydrogen sulfide
Products and output:
Sulfur—10 ton/day
Personnel: W. T. Hancock, mgr.
Remarks: Operates on hydrogen sulfide from Hancock's own refinery.

HAWTHORNE CHEMICAL CO. 159
Louisiana, Mo.
Approximate investment: $11,000,000
Hydrocarbon raw materials:
Methanol
Ammonia
Natural gas
Products and output:
Methylmethacrylate (monomers & polymers)—35-million lb/yr
Remarks: Parent companies, Hercules Powder Co. & Imperial Chemical Industries Ltd. $11-million project will use methanol and ammonia from Hercules Louisiana, Mo. plant, and natural gas piped from Texas.

HERCULES POWDER CO. 160
Hercules, Calif.
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—50,000 ton/yr
Personnel E. St. P. Bellinger, mgr.

HERCULES POWDER CO. 161
Louisiana, Mo.
Approximate investment: $5,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—40,000 ton/yr
Pentaerythritol—24,000,000 lb/yr
Formaldehyde—100,000,000 lb/yr
Methanol—7,000,000 gal/yr
Methyl methacrylate
Personnel: J. B. Talley, mgr.
Remarks: New formaldehyde and pentaerythritol units, at cost of $6-million, now in production. $2-million methanol unit under construction as part of pentaerythritol production.

HERCULES POWDER CO. 162
Burlington, N. J.
Approximate investment: $4,500,000
Hydrocarbon raw materials:
Paraxylene
Products and output:
Dimethyl terephthalate—12,000,000 lb/yr
Personnel: D. A. Bunce, mgr.

HERCULES POWDER CO. 163
Gibbstown, N. J.
Hydrocarbon raw materials:
Benzene and propylene
Cumene
Products and output:
Cumene
Cumene hydroperoxide
Phenol—26,000,000 lb/yr
Acetone—16,000,000 lb/yr
Para-cresol—3,000,000 lb/yr
Cymene alcohol
Methylstyrene
a-Methylstyrene
Acetophenone
Personnel: L. W. Rothenberger, mgr.
Remarks: Company has pilot scale manufacture of dicumyl peroxide, a cumene derivative.

HERCULES POWDER CO. 164
Parlin, N. J.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Polyethylene—30,000,000 lb/yr
Personnel: E. F. Jennings, Jr., mgr.
Remarks: Uses Ziegler process license. In operation July, 1957.

HERESITE CHEMICAL CO. 165
Manitowoc, Wis.
Hydrocarbon raw materials:
Butadiene and styrene
Products and output:
Polybutadiene-acrylonitrile type acyclic elastomers
Personnel: I. L. Place, mgr.

HEYDEN CHEMICAL CORP.
New part of Heyden Newport Chemical Corp.

HEYDEN NEWPORT CHEMICAL CORP. 166
Heyden Fords, N. J.
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Methanol (from natural gas)
Products and output:
Pentaerythritol—25 million lb/yr
Remarks: Under construction. Completion scheduled for July, 1957. Formerly Heyden Chemical Corp. plant.

HIDALGO CHEMICAL CO.
Brownsville, Tex.
Merged into Amoco Chemicals Corp. by parent, Standard Oil Co. (Ind.).

HOOKER ELECTROCHEMICAL CO. 167
Niagara Falls, N. Y.
Hydrocarbon raw materials:
Benzene
Toluene
Xylene
Pentane
Wax
Products and output:
Chlorobenzenes
Chlorotoluenes and their derivatives
Chlorinated waxes
Hexachlorocyclopentadiene
Personnel: R. F. Schultz, wks mgr; D. E. Springer, chf engr; M. L. Parker, prod supt.
Remarks: Durez Plastics and Chemicals, Inc. was consolidated into Hooker in April, 1955, and Niagara Alkali was consolidated into Hooker in Nov., 1955. Oldbury Electro-Chemical Co. was consolidated into Hooker in Nov., 1956.

J. M. HUBER CORP. 168
Borger, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks—74 ton/day
Furnace blacks—90 ton/day
Personnel: H. S. Barbour, genl mgr; J. L. Speir, channel plt supt; L. V. Moxom, furnace plt supt; J. D. McGregor, chf engr.
Remarks: A 20-30 million lb/yr furnace black plant being planned to add 15% to company's furnace black capacity, completion date not set.

J. M. HURER CORP. 169
Eldon, Texas
Hydrocarbon raw materials:
Oil
Products and output:
Carbon black—110 ton/day
Personnel: M. D. Nuttall, mgr; J. B. Stewart, supt; Paul Post, chf engr.

HUMBLE OIL & REFINING COMPANY 170
Baytown, Texas
Approximate investment: $47,982,600
Hydrocarbon raw materials:
Refinery gases
Petroleum fractions
Products and output:
Toluene
Solvent xylene
Paraxylene
Aromatic quench oil
High boiling range aromatic solvents
Narrow boiling range aliphatic naphthas (hexane, heptane, octane)
Special naphthas
Cyclohexane
Tetrapropylene
Tripropylene
Normal butylene
Isobutylene
Propylene concentrate
Carbon black oil feed stock
Butadiene—65,000 ton/yr
Butyl rubber—44,500 long ton/yr
Personnel: G. L. Farned, plts mgr; J. Harrap, genl supt; E. F. Voss, chf engr.
Remarks: 30-million gal/yr benzene unit by Badger, for late 57; 80-million lb/yr ethylene unit, by Kellogg, for fall of 58; 13,000 lb/yr butyl rubber expansion, by Humble, for early 58.

I & J

INDEX CHEMICALS CO. 171
Houston, Texas
Hydrocarbon raw materials:
Butane and sulfur
Products and output:
Thiophene
Methyl, ethyl and octyl mercaptans
Dimethyl and diethyl sulfides
Remarks: Industrial Division, Pennsalt Chemicals Corp. has licensing agreement with Socony Mobil Oil Co. to manufacture and sell thiophene under Socony patents. Plant at Houston is operated by Index Chemical Co., a subsidiary of Pennsalt Chemicals Corp.

JEFFERSON CHEMICAL CO. 172
Port Neches, Texas
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene glycol
Diethylene glycol
Triethylene glycol
Polyethylene glycols
Ethylene carbonate
Propylene carbonate
Piperazine
Ethylene oxide
Ethylene dichloride
Mono-, di-, tri-ethanolamines
Nonyl phenol
Aromatic distillate
Morpholine
Personnel: L. R. Strawn, genl mgr-mfg; B. A. Davis, prod supt; M. H. Holmes, plt mgr; R. H. Darling, chf engr.
Remarks: Parents, American Cyanamid Co. and The Texas Co. Plan $38-million expansion of chlorine, caustic soda, ethylene, ethylene oxide and ethylene glycol facilities.

JEFFERSON LAKE SULPHUR CO. 173
Manderson, Wyo.
Approximate investment: $700,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—50,000 long ton/yr
Personnel: C. H. Lewis, genl mgr; James Leeper, supt.
Remarks: Operating at about 50% of capacity because of shortage of acid gas supplies.

K & L

M. W. KELLOGG CO.
Houston, Texas
Remarks: Company has purchased land on the Houston Ship Channel but has made no definite commitment on use. Kellogg holds a Phillips polyethylene process license, but has announced that will not build the poly ethylene plant.

KENDALL REFINING CO. 174
Bradford, Penna.
Hydrocarbon raw materials:
Petroleum fractions

Products and output:
Heavy hydrocarbons
Petroleum polymer & condensation resins
Personnel: H. V. Smith, mgr; S. M. Wolbert, chf engr.

KOPPERS CO., INC.
Wilmington, Calif.
Remarks: Plans to build polyethylene plant jointly with Brea Chemicals Co., have been cancelled.

KOPPERS CO., INC. 175
Woodbridge, N. J.
Hydrocarbon raw materials:
Ethylene
Products and output:
Polyethylene—30-million lb/yr
Personnel: E. H. Tenthoff, mgr.
Remarks: New plant under construction, completion Sept. 57. Koppers, engr.-contr. Ethylene to come from Esso's new unit being built at Linden.

KOPPERS CO., INC. 176
Monaca, Penna. (Kobuta Plant)
Approximate investment: $25,000,000
Hydrocarbon raw materials:
Benzene and ethylene
Products and output:
Styrene—90,000 ton/yr
Polystyrene—25,000 ton/yr
Divinyl benzene
Personnel: W. K. Todd, mgr; H. Johnson, chf engr; M. R. Dawson & L. Wilkins, asst mgrs.

KOPPERS CO., INC. (Chemical Div.) 177
Oil City, Penna.
Approximate investment: $2,000,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alkylated cresols—5-million lb/yr
Personnel: C. L. Mehring, mgr.

KOPPERS CO., INC. (Chemical Div.) 178
Port Arthur, Tex. (Williams Plant)
Approximate investment: $19,000,000
Hydrocarbon raw materials:
Ethylene
Benzene
Products and output:
Ethylbenzene—120-million lb/yr
Polyethylene—18-million lb/yr
Personnel: H. E. Roche, genl mgr; D. B. Stewart, asst mgr.

LEONARD REFINERIES, INC. (Leonard Refinery Div.) 179
Alma, Mich.
Products and output:
Sulfur
Cresylic acid
Personnel: R. W. Pollard, mgr; C. E. Weaver, oper supt.

LEONARD REFINERIES, INC. (Roosevelt Refinery Div.) 180
Mt. Pleasant, Mich.
Approximate investment: $2,000,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene and toluene—5.5-million gal/yr
T-x concentrate—500,000 gal/yr
Mineral seal oil—1-million gal/yr
Aliphatic naphthas & solvents—18-million gal/yr
Personnel: T. J. Williams, mgr; B. Weber, asst supt.

LUBRIZOL CORP. 181
Cleveland, Ohio
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Chemical additives for lubes
Personnel: C. G. O'Bannon, prod mgr.

LUBRIZOL CORP. 182
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Personnel: K. A. Danskin, mgr.

LYNN CARBON BLACK CO. 183
San Angelo, Texas
Approximate investment: $175,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—12-million lbs/yr
Personnel: W. H. Balka, engr consultant

M

MAGNOLIA PETROLEUM CO. 185
Beaumont, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Cresylic acid
Personnel: R. G. Sanders, VP in charge; P. L. Smith, mgr; C. M. Fabian, supt; G. C. Defrey, chf engr.
Remarks: Parent, Socony Mobil Oil Co., Inc.

MARBON CHEMICAL DIV.—BORG-WARNER CORP. 186
Gary, Indiana
Hydrocarbon raw materials:
Acrylonitrile
Butadiene
Styrene
Products and output:
High styrene resins for rubber & paint
Rubber-to-metal adhesives
ABS "Hi Impact" resins
Personnel: Robert Shattuck, mgr; J. F. Showalter, supt.

MARBON CHEMICAL DIVISION—BORG-WARNER CORP. 187
Washington, W. Va.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Acrylonitrile
Butadiene
Styrene
Products and output:
ABS high impact resins
Personnel: Robert Shattuck, mgr; Byron Bailey, supt; Carl Taylor, chf engr.
Remarks: Commenced operations March 1957.

THE MERICHEM CO. (Div., Jefferson Lake Sulphur Co.) 188
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Cresylic acid
Phenol
Cresols
Personnel: J. I. Files, VP; J. D. Ligon, plt mgr; L. J. Jolly, supt.
Remarks: $1-million expansion program under construction. Engr, Tears; contr, Brown & Root.

MISSISSIPPI CHEMICAL CORP. 189
Yazoo City, Miss.
Approximate investment: $18,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—95,000 ton/yr
Nitric acid—114,000 ton/yr
Ammonium nitrate—160,000 ton/yr
Personnel: W. B. Dunwoody, genl opers mgr; J. R. Phillips, asst genl mgr; J. D. Drake, chf engr.

MISSISSIPPI RIVER CHEMICAL CO. (Div., Mississippi River Fuel Corp.) 190
Selma, Mo.
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—72,000 ton/yr
Nitric acid—79,200 ton/yr
Ammonium nitrate—100,800 ton/yr
Personnel: C. H. Lashlee, plt mgr.

MOBAY CHEMICAL CO. 191
New Martinsville, W. Va.
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Toluene diamine
Adipic acid
Ethylene glycol
Products and output:
Isocyanates
Polyesters
Butylene glycol
Phthalic anhydride
Personnel: D. J. Miller, plt mgr; R. F. Cassidy, prod supt.
Remarks: Company is owned jointly by Monsanto Chemical Co. and Farbenfabriken Bayer A. G. of Germany. Isocyanates and polyesters capacities are being tripled. Blaw-Knox holds construction contract.

MONSANTO CHEMICAL CO. 192
Avon, Calif.
Approximate investment: $5,000,000
Hydrocarbon raw materials:
Benzene
Acid sludge
Products and output:
Phenol—20-million lb/yr
Sulfuric acid—80,000 ton/yr
Personnel: P. W. Edwards, mgr.

MONSANTO CHEMICAL CO. 193
Texas City, Texas
Approximate investment: $15,300,000 (for vinyl chloride and methanol only)
Hydrocarbon raw materials:
Benzene
Ethylene
Methane
Propane
Natural gas
Products and output:
Hydrogen cyanide
Styrene monomer—140,000 ton/yr
Vinyl chloride
Acrylonitrile
Polyethylene—66-million lb/yr
Methanol—25-million gal/yr
Acetylene
Tertiary butylamine
Ethyl benzene
Ethylene dichloride
Personnel: J. S. Putnam, plt mgr; H. K. Eckert, dir of mfg.
Remarks: Methanol unit operated by Monsanto and Heyden Newport Chemical Co. 150% ethylene expansion program completed early 57. N-butane, ethylene plant being built for internal use.

MONSANTO CHEMICAL CO. Inorganic Chemicals Division 194
El Dorado, Ark.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia
Ammonium sulfate
Ammonium nitrate
Aqua ammonia
Fertilizer solutions
Nitric acid
Nitrogen solutions
Sulfuric acid
Personnel: A. M. Sprague
Remarks: 40 ton/day, 95% nitric acid concentration facilities being built by Chemical & Industrial Corp.

MONSANTO CHEMICAL CO. Inorganic Chemicals Division 195
Luling, La. (Barton plant)
Hydrocarbon raw materials:
Natural gas
Waste gases
Products and output:
Adipic acid
Anhydrous ammonia
Ammonium nitrate
Dry ice and liquid CO_2
Nitrate—urea solutions
Nitric acid
Personnel: R. L. Van Zandt, mgr.

MONTANA SULPHUR & CHEMICAL CO. 196
Billings, Mont.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfur—40 ton/day
Personnel: D. G. Zink, Pres; J. R. Butler, VP.

MONTROSE CHEMICAL CO. 197
Newark, N. J.
Hydrocarbon raw materials:
Cresylic acid
Products and output:
Tricresyl phosphate
Personnel: B. Rothberg, VP; F. G. Radis, supt.

MORTON-WITHERS CHEMICAL CO. 198
Greensboro, N. C.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sulfonates
Synthetic lubes
Lube oil additives
Total—20-million lb/yr
Personnel: R. T. Masters, supt.

MOUNTAINEER CARBON CO. 199
Cresap, W. Va.
Approximate investment: $1,500,000

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 139-149. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 360 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

Hydrocarbon raw materials:
Petroleum coke
Products and output:
Electrode carbon—165,000 ton/yr
Personnel: N. E. Sylvander is overall project mgr.
Remarks: Parents, Standard Oil Co. (Ohio) and Pittsburgh Consolidation Coal Co. Feed is initially petroleum coke from Sohio. At a later date, coke similar to petroleum coke, will be produced from low temperature tar. Plant to start Jan. 1958.

N

NATIONAL PETRO-CHEMICALS CO. 200
Tuscola, Ill.
Approximate investment: $70,000,000
Hydrocarbon raw materials:
Ethylene
Natural gas
Products and output:
Ethyl alcohol—40-million gal/yr
Ethyl chloride—60-million lb/yr
Polyethylene—50-million lb/yr
Ether—4.5-million gal/yr
Personnel: J. W. Nixon, mgr; C. E. Oman, proc supt; C. D. Carnes, chf engr.

NATURAL GAS ODORIZING, INC. 201
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Mercaptans
Gas odorants
Personnel: W. M. Wilkinson, Pres; W. H. Dickerson, plt mgr.

NECHES BUTANE PRODUCTS CO. 202
Port Neches, Texas
Approximate investment: $53,000,000*
Hydrocarbon raw materials:
Butylenes
Products and output:
Butadiene—200,000 short ton/yr
Personnel: W. H. Hoffman, Pres; M. L. Rosenberg, VP; R. S. Crockett, VP; F. R. Jelinck, chf engr.
Remarks: *Purchase price from U. S. Government. Owned 50-50 by Texas-U. S. Chemical Co. and Goodrich-Gulf Chemical Co. Expansion of butadiene plant from 200 to 300 thousand short ton/yr to be complete by fall of 1957.

NEVILLE CHEMICAL CO. 203
Anaheim, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Hydrocarbon resins
Aromatic solvents
Personnel: R. L. Ulrich, mgr; J. Christianson, supt.

NEVILLE CHEMICAL CO. 204
Neville Island (Pittsburgh) Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Hydrocarbon resins
Aromatic solvents
Personnel: L. V. Dauler, Pres; J. Shearer, supt; L. J. Sitomer, chf engr.

NEWPORT INDUSTRIES, INC.
Now Newport Industries Co., a division of Heyden Newport Chemical Corp.

NEWPORT INDUSTRIES CO.
(Div., Heyden Newport Chemical Corp.) 205
Pensacola, Fla.
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen
Personnel: H. L. Marter, VP-prod; R. F. Cole, chf engr.

NINOL LABORATORIES 206
Chicago, Ill.
Approximate investment: $750,000
Hydrocarbon raw materials:
Alkylated benzene
Products and output:
Special sulfonates—15-million lb/yr
Personnel: Jerome Kritchevsky, Pres.

NOPCO CHEMICAL CO. 207
Richmond, Calif.
Hydrocarbon raw materials:
Crude petroleum sulfonates
Naphthenates
Products and output:
Naphthenic acid
Lube oil additives
Polyvinyl acetate emulsions
Plasticizers
Personnel: J. E. Connelly, mgr.

NORTHERN CHEMICAL INDUSTRIES, INC. 208
Searsport, Maine
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Bunker C fuel oil
Products and output:
Anhydrous ammonia—45,000 ton/yr
Nitric acid—21,600 ton/yr
Mixed fertilizer—50,000 ton/yr
Sulfuric acid—70,000 ton/yr
Personnel: F. L. Litty, mgr; G. Odom, chf engr.
Remarks: Use Texaco partial oxidation process. Onstream late 1956.

NUODEX PRODUCTS CO. 209
Long Beach, Calif.
Hydrocarbon raw materials:
Petroleum derivatives
Products and output:
Naphthenates
Fungicides
Bactericides
Additives
Personnel: A. J. Roubo, mgr.
Remarks: Parent, Heyden Newport Chemical Corp.

NUODEX PRODUCTS CO. 210
Elizabeth, N. J.
Hydrocarbon raw materials:
Petroleum derivatives
Products and output:
Naphthenates
Fungicides
Bactericides
Additives
Personnel: J. F. Kilcullen, mgr.

NUODEX PRODUCTS CO. 211
Newark, N. J.
Hydrocarbon raw materials:
Petroleum derivatives
Products and output:
Naphthenates
Fungicides
Bactericides
Additives
Personnel: R. A. Allen, mgr.

O

ODESSA BUTADIENE CO. 212
Odessa, Texas
Hydrocarbon raw materials:
Butane
Benzene
Products and output:
Butadiene—50,000 ton/yr
Styrene—35-million lb/yr
Personnel: W. W. Mize, mgr; D. C. Klein, asst. mgr; M. Atcheson, chf engr.
Remarks: El Paso Natural Gas Products Co., majority owner and operator. Butadiene to be onstream about Aug 1957 and styrene plant onstream early 1958. Total cost of both plants $27-million.

OLIN MATHIESON CHEMICAL CORP. 213
Magnolia, Ark.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur
Personnel: O. W. Taylor, mgr.

OLIN MATHIESON CHEMICAL CORP. 214
McKamie, Ark.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur
Personnel: O. W. Taylor, mgr.

OLIN MATHIESON CHEMICAL CORP. 215
Brandenburg, Ky.
Hydrocarbon raw materials:
Ethane (from natural gas)
Products and output:
Ethylene oxide
Ethylene glycol
Diethylene glycol
Ethylene dichloride
Triethylene glycol
Polyglycols
Glycol ethers
Ethanolamines
Dichloroethyl ether
Ethylene diamine
Polyamines
Personnel: C. J. Thomas, mgr; C. C. Hale, mgr. of engrg.

OLIN MATHIESON CHEMICAL CORP. 216
Lake Charles, La.
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—95,000 ton/yr
Nitric acid
Sodium nitrate
Hydrazine
Personnel: C. C. Hightower, mgr; W. C. Maley, asst. mgr; A. D. Hargrader, chf engr.

ORONITE CHEMICAL CO. 217
Oak Point, La.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Furnace oil additives
Gas odorants
Nonionic detergents
Algicides
Alkyl phenols
Lube oil additives
Personnel: W. K. Venatta, mgr; F. A. Tannahill, supt.
Remarks: Parent, California Chemical Co., a subsidiary of Standard Oil Co. of Calif.

P & Q

PAN AMERICAN PETROLEUM CORP. 218
North Cowden, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—6,200 ton/yr
Personnel: E. R. Wagner, supt.
Remarks: Formerly Stanolind Oil & Gas Co. Parent, Standard Oil Co. (Ind.)

PAN AMERICAN PETROLEUM CORP. 219
Odessa, Texas
Hydrocarbon raw materials:
Hydrogen sulfide
Products and output:
Sulfur—3,650 ton/yr.
Personnel: L. E. Childers, supt.
Remarks: Formerly Stanolind Oil & Gas Co. Parent, Standard Oil Co. (Ind.) Sulfur recovery unit added to existing Midland Farms Gasoline Plant, completed Sept. 1956.

PAN AMERICAN PETROLEUM CORP. 220
Sundown, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—17,150 ton/yr
Personnel: H. K. Boswell, supt.
Remarks: Formerly Stanolind Oil & Gas Co. Parent, Standard Oil Co. (Ind.)

PAN AMERICAN PETROLEUM CORP. 221
Powell, Wyo. (Elk Basin Field)
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—23,700 ton/yr
Personnel: A. H. Denny, supt.
Remarks: Formerly Stanolind Oil & Gas Co. Parent, Standard Oil Co. (Ind.)

PAN-AM SOUTHERN CORP.
Merged into American Oil Co., by parent, Standard Oil Co. (Ind.)

PATHFINDER CHEMICAL CO.
Taken into parent company, Goodyear Tire & Rubber Co., on Jan. 1, 1957. Now known as the Niagara Falls Plant of Goodyear.

PENNSYLVANIA INDUSTRIAL CHEMICAL CORP. 222
Chester, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Petroleum resins
Toluol
Xylol
Aromatic naphthas
Naphthalene
Aromatic oils
Personnel: J. D. Vermeychuk, supt; W. D. Johnston, chf engr.
Remarks: This is a small 100,000 gal/dy plant.

PENNSYLVANIA INDUSTRIAL CHEMICAL CORP. 223
Clairton, Penna. (West Elizabeth)
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Styrene
Petroleum resins
Aromatic solvents
Personnel: E. A. Taylor, mgr.
Remarks: West Elizabeth operates on variety of materials, petroleum and coal-tar derivatives, and acts as "feeder" to main plant at Clairton, where all raw materials are coal-tar at present.

PENNSYLVANIA REFINING CO. 224
Karns City, Penna.
Approximate investment: $500,000

Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Petroleum sulfonate—5-million lb/yr
Personnel: John Beck, mgr; C. M. McCullough supt.

PENNSALT CHEMICALS CORP. (Industrial Div.) 225
Riverview, Michigan
Hydrocarbon raw materials:
Pentane
Tri-isobutylene
Products and output:
Amyl alcohol
Amyl chloride
Amyl acetate
Amyl phenols
Amyl naphthalenes
Tert-dodecylmercaptan
Personnel: H. J. Eichenhofer, area mgr; R. V. Laitner, prod mgr; Dr. L. A. Gillette, tech mgr.

PENNSALT CHEMICALS CORP. (Industrial Div.) 226
Wyandotte, Mich.
Hydrocarbon raw materials:
Pentane fractions
Tri-isobutylene
Products and output:
Pentane—1 & 2 Mixed pentanes
Amyl alcohol
Amyl chloride
Amyl acetate
Amyl phenols
Amyl naphthalenes
Amyl mercaptan
Tert-dodecylmercaptan
Tert-dodecylether
Polyethylene glycol
Remarks: Formerly Sharples Chemical Div. of Pennsalt.

PETROCARBON CHEMICALS, INC. 227
Irving, Texas
Approximate investment: $2,000,000
Hydrocarbon raw materials:
Crude oil
Products and output:
Aliphatic solvents
Aromatic solvents
Personnel: Dr. J. Shoaf, supt; John Hearne, chf engr.

PETROLEUM CHEMICALS, INC. 228
Lake Charles, La.
Approximate investment: $22,500,000
Hydrocarbon raw materials:
Refinery gases
Products and output:
Butadiene—80,000 ton/yr
Personnel: Bruce K. Brown, Pres; F. M. Simpson, Exec VP; J. H. Olehy, genl mgr-mfg; L. D. Grubb, regional mgr-Lake Charles.
Remarks: A 100,000 ton/yr anhydrous ammonia plant is being built by the Foster Wheeler Corp. at an estimated cost of $12.5-million and is scheduled for completion in the fall of 1957. A 200-million lb/yr ethylene plant is being built by Lummus Co. and is scheduled for completion the first of 1958. Engineering work by the Foster Wheeler Corp. s being done for a 30,000 ton/yr butyl rubber plant. PCI is building for the account of the Calcasieu Chemical Corp., a 8-million gal/yr of ethylene glycol plant. The contractor is Lummus Co.

PETRO-TEX CHEMICAL CORP. 229
Houston, Tex.
Hydrocarbon raw materials:
Butane
Butylene
Products and output:
Butadiene-1,3—200,000 ton/yr
n-Butylene-1
n-Butylene-2
Personnel: J. O'C. Brown, mgr; D. V. Fitz, supt; L. L. Hess, plt engr and maint supt.
Remarks: Petro-Tex is jointly and equally owned by Tennessee Gas Transmission Co. and Food Machinery & Chemical Corp. Two Houdry n-butane dehydrogenation units completed April 1957 are producing additional 110,000 short ton/yr butadiene.

PHILLIPS CHEMICAL CO.
Andrews County, Texas
Remarks: Plans deferred for sulfur-from-natural gas plant here.

PHILLIPS CHEMICAL CO. 230
Big Spring, Texas
Hydrocarbon raw materials:
Mixed xylenes
Products and output:
Paraxylene—3,540,500 lb/yr
Personnel: A. F. Legatski, supt.
Remarks: Subsid of Phillips Petroleum Co. Plant operated by Cosden Petroleum Corp.

PHILLIPS CHEMICAL CO. 231
Borger, Texas
Hydrocarbon raw materials:
Gas oil
Products and output:
Furnace blacks, Philblack—290-million lb/yr
Personnel: H. E. Haltom, supt.
Remarks: Subsid of Phillips Petroleum Co.

PHILLIPS CHEMICAL CO. 232
Borger, Texas
Hydrocarbon raw materials:
Butane
Styrene
Butadiene
Products and output:
Butadiene—110,000 short ton/yr
SBR rubber, Philprene—108,000 long ton/yr
Personnel: G. H. Short, mgr.
Remarks: Subsid of Phillips Petroleum Co.

PHILLIPS CHEMICAL CO. 233
Crane County, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—36,500 long ton/yr
Personnel: A. F. Legatski, superintendent
Remarks: Subsid of Phillips Petroleum Co.

PHILLIPS CHEMICAL CO. 234
Etter, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—191,600 ton/yr
Ammonium nitrate—142,000 ton/yr
Nitrogen solutions—55,000 ton/yr
Nitric acid—130,000 ton/yr
Personnel: C. W. Forman, supt.
Remarks: Subsid of Phillips Petroleum Co.

PHILLIPS CHEMICAL CO. 235
Goldsmith, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—36,500 long ton/yr
Personnel: A. F. Legatski, supt.
Remarks: Subsid of Phillips Petroleum Co.

PHILLIPS CHEMICAL CO. 236
Pasadena, Texas
Hydrocarbon raw materials:
Ethylene
Natural gas
Methylethylpyridine
Products and output:
Rigid polyethylene, Marlex 50—75-million lb/yr*
Ammonia—191,600 ton/yr
Ammonium Sulfate—365,000 ton/yr
Triple superphosphate—147,800 ton/yr
Methylvinylpyridine—3-million lb/yr
Personnel: L. H. Johnstone, mgr.
Remarks: *Capacity of facilities to be completed in 1957.
Subsid of Phillips Petroleum Co.

PHILLIPS CHEMICAL CO. 237
Sweeny, Texas
Hydrocarbon raw materials:
Butane and/or propane
Products and output:
Ethylene—180-million lb/yr.
Personnel: G. A. Ibach, supt.
Remarks: Subsid of Phillips Petroleum Co.

PHILLIPS CHEMICAL CO.
Gulf Coast location
Remarks: Plans for 64-million lb/yr carbon black-from-oil plant here deferred.

PHILLIPS PACIFIC CHEMICAL CO. 238
Kennewick, Wash.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—73,000 short ton/yr.
Personnel: W. D. Payton, supt.
Remarks: Jointly owned by Phillips Petroleum Co. and Pacific Pipeline Corp. Operated by Phillips Chemical Co.

PHILLIPS PETROLEUM CO. 239
Kansas City, Kansas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Rubber extender & process oils
Personnel: C. V. Cavin, plt supt.

PHILLIPS PETROLEUM CO. 240
Phillips, Texas (Borger Fractionator)
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Di-isopropyl
Cyclohexane
Hydrogen sulfide
Hydrofluoric alkylate
Ethyl mercaptan
Personnel: A. W. Paris, dist. supt.

PHILLIPS PETROLEUM CO. 241
Phillips, Texas (Philtex Plant)
Hydrocarbon raw materials:
Petroleum and natural gas fractions
Products and output:
Methane
Ethane
Propane
Isobutane
n-Butane
Neopentane
Isopentane
n-Pentane
Neohexane
Diisopropyl
2-Methylpentane
3-Methylpentane
n-Hexane
2,4-Dimethylhexane
2,3-Dimethylhexane
3-Methylhexane
n-Heptane
2,2,4-Trimethylheptane
n-Octane
Dimethylhexanes
Trimethylpentanes
2,2,5-Trimethylhexane
n-Nonane
n-Decane
n-Undecane
Tridecane
Ethylene
Propylene
Isobutylene
Butene-1
cis-Butene-2
trans-Butene-2
3-Methylbutene-1
Pentene-1
2-Methylbutene-1
Pentene-2
2-Methylbutene-2
4-Methylpentene-1
4-Methylpentane-2
2-Methylpentene-1
Hexene-1
Hexene-2
Hexene-3
Heptene-2
Heptene-3
2,4,4-Trimethylpentene-1
Octene-1
Octene-2
2,6-Dimethylheptene-3
Cyclopentane
Methylcyclopentane
Methylcyclohexane
Cyclopentene
Cyclohexene
4-Methylcyclohexene-1
4-Vinylcyclohexene-1
1-Phenylbutene-2
1,5-Cyclooctadiene
Butadiene-1,3
Liquid Polybutadiene (Butarez)
Isoprene
Pentadiene-1,3
Benzene
Toluene
Ethylbenzene
para-Xylene
meta-Xylene
ortho-Xylene
Cumene
1,2,4-Trimethylbenzene
tert-Butylbenzene
sec-Butylbenzene
n-Butylbenzene
Butadiene-Furfural Cotrimer
tert-Butyl Mercaptan
tert-Amyl Mercaptan
Hexyl Mercaptan
tert-Heptyl Mercaptan
tert-Octyl Mercaptan
tert-Nonyl Mercaptan
tert-Dodecyl Mercaptan
tert-Tetradecyl Mercaptan

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 139-149. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 360 petrochemicals

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tert-Hexadecyl Mercaptan
Phenylethyl Mercaptan
Diphenylethyl Sulfide
Ditertiarybutyl Sulfide
Diethyl Disulfide
Ditertiarybutyl Disulfide
Ditertiaryamyl Disulfide
Diteritaryhexyl Disulfide
Ditertiaryheptyl Disulfide
Ditertiarydodecyl Disulfide
Ditertiarytetradecyl Disulfide
Ditertiarybutyl Polysulfide
Ditertiaryamyl Polysulfide
Ditertiaryoctyl Polysulfide
Ditertiarydodecyl Polysulfide
Diisobutylene
Cyclohexane
Odorless Solvents (Soltrols)
Precipitation and Dilution Naphthas
Petroleum Ether
Personnel: A. A. Roho, plt supt.

PITT-CONSOL CHEMICALS CO. 242
Newark, N. J.
Approximate investment: $3,500,000
Hydrocarbon raw materials:
Refinery fractions, mainly spent caustics
Products and output:
Cresols and cresylic acid
Phenolic moulding compounds
Phenols
Resins
Rubber chemicals
Personnel: R. H. Martin, genl mgr; R. L. Comstock, plt supt; E. T. Rudy, chf engr.
Remarks: Parent, Pittsburgh Consolidation Coal Co. New cresylic acid unit went onstream Jan. 1, 1957.

PRODUCTOL CO. 243
Santa Fe Springs, Calif.
Hydrocarbon raw materials:
Petroleum and coal tar fractions
Products and output:
Phenol
Cresols and Cresylic acid
Naphthalene
Personnel: E. E. Chipman, mgr; J. W. Burrow, supt.

PURE OIL CO. 244
Lemont, Ill.
Approximate investment: $300,000
Hydrocarbon raw materials:
Refinery gases
Products and output:
Sulfur—5,250 ton/yr
Personnel: J. M. Lawson, mgr.

PURE OIL CO. 245
Toledo, Ohio
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Toluene—2°
Xylene
Aromatic fractions
Solvents
Personnel: H. H. Dronberger, mgr.
Remarks: Aromatic products all going into motor fuel at present.

PURE OIL CO. 246
Nederland, Texas
Hydrocarbon raw materials:
Petroleum fractions
Refinery gas streams
Products and output:
Lube oil additives
Solvents
1-Butene
2-Butene
Butene mixtures
Petroleum and condensation resins
Non-paraffin concentrates
Personnel: C. W. Cooper, mgr; I. L. Hostetler, genl supt.

PUREX CORP. 247
South Gate, Calif.
Hydrocarbon raw materials:
Propylene
Products and output:
Sulfonated alkyl benzene
Personnel: S. M. Dahl, prod mgr.

PUREX CORP. 248
St. Louis, Mo.
Hydrocarbon raw materials:
Propylene
Products and output:
Sulfonated alkyl benzene
Personnel: John B. Cravey, supt.

QUAKER CHEMICAL PRODUCTS CORP. 249
Conshohocken, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Detergents
Metal cleaners
Textile finishing compounds
Corrosion preventives
Personnel: Wm. J. Gavin, mgr.

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REICHHOLD CHEMICALS CO. 250
Tuscaloosa, Ala.
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Methanol
Formalin-acetaldehyde
Benzene
Products and output:
Pentaerythritol—5-million lb/yr
Formaldehyde—30-million lb/yr
Synthetic resins
Phenol—50-million lb/yr
Personnel: W. O. Fetterly, plt mgr; B. F. Galloway, supt.
Remarks: Pentaerythritol production to be doubled and phenol increased 50% to 75-million lb/yr. Also will build a new 35-million lb/yr formaldehyde unit. Construction by staff.

REICHHOLD CHEMICALS CO. 251
Azusa, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Phthalic anhydride—10-million lb/yr
Personnel: J. H. Zeller, mgr; J. E. Jared, supt.
Remarks: 10-million lb/yr phthalic anhydride plant onstream July, 1957.

REICHHOLD CHEMICALS CO. 252
San Francisco, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Personnel: M. W. Reece, genl mgr; S. W. Small, plt mgr; C. A. Koski, supt.

REICHHOLD CHEMICALS CO. 253
Jacksonville, Fla.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Personnel: R. B. Fellows, mgr.

REICHHOLD CHEMICALS CO. 254
Pensacola, Fla.
Hydrocarbon raw materials:
Methanol
Remarks: Plant financed and wholly owned by Escambia Chemical Corp. Reichhold takes total output for its own internal usage and for general marketing.

REICHHOLD CHEMICALS CO. 255
Ballardvale, Mass.
Hydrocarbon raw materials:
Petroleum fractions
Methanol
Products and output:
Synthetic resins
Formaldehyde
Personnel: R. T. Urich, genl mgr; H. F. Shepard, plt mgr.

REICHHOLD CHEMICALS CO. 256
Detroit, Mich.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Synthetic resins
Phthalic anhydride—8,000,000 lb/yr
Personnel: C. J. Windsor, mgr; J. W. Milford.
Remarks: Company engineering staff to build a 35-million lb/yr formaldehyde unit. Completion date early 58.

REICHHOLD CHEMICALS CO. 257
Elizabeth, N. J.
Hydrocarbon raw materials:
Petroleum fractions
Benzene
Products and output:
Synthetic resins
Maleic anhydride—2-million lb/yr
Personnel: J. E. d'Angelo, mgr; C. G. Matko, chf engr.
Remarks: Company has plans for $10-million in expansion throughout all plants, including following product capacity expansions: phenol, pentaerythritol, phthalic anhydride, maleic anhydride, formaldehyde, glycerine. Engineering & construction by staff. No completion date set.

REICHHOLD CHEMICALS CO. 258
Charlotte, N. C.
Hyrocarbon raw materials:
Petroleum fractions
Methanol
Products and output:
Synthetic resins
Formaldehyde
Personnel: G. D. Hanner, supt.

REICHHOLD CHEMICALS CO. 259
Seattle, Wash.
Hydrocarbon raw materials:
Petroleum fractions
Phenol (chlorinated)
Products and output:
Synthetic resins
Formaldehyde
Pentachlorophenol—360,000 lb/yr
Personnel: H. O. Warner, plt mgr; C. E. Ruiga, chf engr.

REICHHOLD CHEMICALS CO. 260
Tacoma, Wash.
Hydrocarbon raw materials:
Benzene
Products and output:
Phenolic resins
Pentaclorphenol—4,000,000 lb/yr
Plywood glues—24,000,000 lb/yr
Formaldehyde
Personnel: H. O. Warner, plt mgr; R. Rose, supt; C. E. Ruiga, chf engr.
Remarks: Plant onstream since April, 1956. The new formaldehyde plant was completed April, 1957.

REPUBLIC OIL REFINING CO. 261
Texas City, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Propylene tetramer—16,500,000 lb/yr
Propylene trimer—24.4-million lb/yr
Personnel: L. W. Robbie, VP & mgr; M. E. Houser, supt; H. Howell, chf engr.
Remarks: 5000 b/d Udex unit in design stages.
Construction to begin last quarter 57. Proposed output: 370 b/d benzene; 900 b/d toluene; 750 b/d xylenes.

RICHFIELD OIL CORP. (Watson Refinery) 262
Los Angeles County, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Hydrogen sulfide—56-million lb/yr
Ethylene—25-million lb/yr
Personnel: C. R. McKay, mgr; R. P. Corlew, asst mgr.
Remarks: Company plans to spend $500,000 to increase capacity for sulfur recovery

ROHM & HAAS CO. 263
Pasadena (Deer Park), Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Hydrogen cyanide
Acetone cyanhydrin
Acrylic chemicals
Higher alcohols
Personnel: V. C. Henrich, mgr; D. W. Kenny, asst to mgr; R. Ayres, chf engr.
Remarks: Company is planning a $10-million unit to make acetylene from natural gas with capacity of about 20-million lb/yr. Will use Texaco-Hydrocarbon Research partial oxidation process. Also planning 100 ton/day methanol plant; licensor, Texaco; engineer contractor, Foster Wheeler.

ROOSEVELT OL & REFINING CO.
Mt. Pleasant, Mich.
Remarks: Now a division of Leonard Refineries, Inc.

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ST. PAUL AMMONIA PRODUCTS, INC. 264
Pine Bend, Minn.
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Natural gas & residual oil
Products and output:
Ammonia—70,000 ton/yr
Ammonium nitrate
Personnel: Frank W. Wilson, genl mgr.
Remarks: Output of plant will be sold to Central Farmers Fertilizer Co. Plant is scheduled for completion Aug. 1, 1957. Engineer contractor is Lummus Co. Will use the Texaco process.

SAN JACINTO CHEMICAL CO. 265
Houston, Texas
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—43,200 ton/yr
Personnel: R. F. Hopkins, Pres; D. A. White, mgr; S. M. Pamplin, prod supt; A. L. Isham, chf engr.
Remarks: Parent, Smith Douglas Co., Inc. of Norfolk, Va.

SEABOARD OIL CO. 266
Powell, Wyo.
Approximate investment: $1,000,000
Hydrocarbon raw materials:
Natural gas

Products and output:
Sulfur—9000 ton/yr
Personnel: W. R. Strong, foreman

SHAMROCK OIL AND GAS CORP. 267
Sunray, Texas
Approximate investment: $285,000
Hydrocarbon raw materials:
Acid gases
Products and output:
Sulfur—10,800 ton/yr
Personnel: A. V. Beckworth, supt; G. L. Wherfry, chf engr.

SHARPLES CHEMICAL DIVISION
(Pennsylvania Salt Mfg. Co.)
Remarks: See Pennsalt Chemicals Corp. (Industrial Div.).
Result of corporate name change.

SHAWINIGAN RESINS CORP. 268
Trenton, Mich.
Approximate investment: $1,000,000 plus
Products and output:
Vinyl butyral resins, Butvar—multi-million lb/yr
Personnel: L. F. Davis, plt mgr.
Remarks: Completion scheduled for Oct. 1957. Parents, Monsanto Chemical Co. & Shawinigan Chemicals, Ltd.

SHELL CHEMICAL CO. 269
Dominguez, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alcohols
Solvents
Other organic chemicals
Personnel: O. M. Williams, mgr.

SHELL CHEMICAL CORP. 270
Martinez, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alcohol
Solvents
Trisubstituted phenol
P-tert butylbenzene acid
Lube oil additives
Personnel: E. W. Casagrande, mgr.

SHELL CHEMICAL CO. 271
Pittsburg, Calif.
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia
Ammonium sulfate
Carbon black
Catalysts
Diammonium phosphate
Personnel: G. S. Williamson, mgr.

SHELL CHEMICAL CO. 272
Torrance, Calif.
Approximate investment: $30,000,000
Hydrocarbon raw materials:
Butylenes
Benzene
Propane
Products and output:
Butadiene—70,000 short ton/yr
Styrene
GR-S rubber—110,000 long ton/yr
Personnel: M. Voogd, mgr.
Remarks: Cost and capacities are those reported at time of purchase of this plant from government, spring, 1955. Additional amounts have since been invested to increase efficiency and versatility of plant.

SHELL CHEMICAL CO. 273
Ventura, Calif.
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—65,000 ton/yr
Urea—36,000 ton/yr
Personnel: F. D. Kuenzly, mgr.

SHELL CHEMICAL CO. 274
Denver, Colo.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Aldrin
Dieldrin
Endrin
"Nemagon" nematocide
Methyl parathion
Insecticide, "Phosdrin"
Specialty chemicals
Personnel: H. E. Hughes, mgr.

SHELL CHEMICAL CORP. 275
Norco, La.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Crude chlorohydrins
Allyl chloride, D-D
Soil fumigant, "D-D"
Hydrogen peroxide
Acrolein
Glycerine—30-million lb/yr
Personnel: F. E. Caddy, mgr.
Remarks: Peroxide unit is under construction, for late 1957 completion. A 40,000,000 lb/yr methyl ethyl ketone unit is under construction, due for completion fall of 1957. Acrolein and glycerine units planned.

SHELL CHEMICAL CORP. 276
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alcohols
Solvents
Soil fumigant, "D-D"
Epon resins
Glycerine
Bis-phenol A
Personnel: Glenn Purcell, mgr.

SHELL OIL CO. 277
Martinez, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
1-Butene
2-Butene
Petroleum sulfonates
Personnel: Bruno Stolley, mgr.

SHELL OIL CO. 278
Wilmington, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene—6-million gal/yr
Cresylic acid
Toluene
Xylenes
Mixed xylenes
Cyclohexane
1-Butene
2-Butene
Personnel: J. P. Merkus, Jr., mgr.

SHELL OIL CO. 279
Wood River, Ill.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Toluene
Xylene
Personnel: H. D. Dale, mgr.

SHELL OIL CO. 280
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Benzene—19,000,000 gal/yr
Toluene—33,000,000 gal/yr
Sulfur—20,000 ton/yr
Personnel: J. A. Tench, mgr.

SID RICHARDSON CARBON CO. 281
Odessa, Texas
Approximate investment: $8,000,000
Hydrocarbon raw materials:
Natural gas
Hydrogen sulfide
Products and output:
Carbon black, Texas blacks—70-million lb/yr
Sulfur—5,000 tons/yr
Personnel: H. H. Offutt, mgr; L. E. King, supt; G. McClure, chf engr.

SID RICHARDSON GASOLINE CO. 282
Kermit, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—10 ton/day
Natural Gasoline
Butanes
Propane
Personnel: D. H. Huff, mgr; S. L. Humphreys, supt; G. McClure, chf engr.
Remarks: Cycling—planning.

Who Makes What Petrochemicals

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. . . plus descriptions of 360 petrochemicals

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SID RICHARDSON GASOLINE CO. 283
Kermit, Texas
Approximate investment: $9,000,000
Hydrocarbon raw materials:
Natural gas
Hydrogen sulfide
Products and output:
Propane—550,000 bbl/yr
Butane—400,000 bbl/yr
Natural gasoline—450,000 bbl/yr
Sulfur—2500 tons/yr
Personnel: S. L. Humphreys, mgr; H. G. Holmes, supt; G. P. McClure, chf engr.

SIGNAL OIL & GAS CO. 284
Tioga, No. Dak.
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Casinghead gas
Products and output:
Sulfur
Personnel: R. L. Cook, supt; F. W. Norton, chf engr.

SINCLAIR REFINING CO. 285
Wood River, Ill.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Aromatic solvents
Personnel: M. H. Nolan, mgr.
Remarks: Sales affiliate, Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp.

SINCLAIR REFINING CO. 286
East Chicago, Ind.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Cresylic acids
Antitoxidants
Aromatic solvents
Gear, turbine & cutting oil additives
Personnel: G. A. Blaine, mgr.
Remarks: Sales affiliate, Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp.

SINCLAIR REFINING CO. 287
Wellsville, N. Y.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Petroleum resins
Personnel: W. B. Chenault, mgr.
Remarks: Sales affiliate, Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp.

SINCLAIR REFINING CO. 288
Sand Springs, Okla.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Demulsifying agents
Corrosion inhibitors
Sulfonates, acid & oil layer types (sodium salt)
Personnel: J. G. Wisherd, mgr.
Remarks: Sales affiliate, Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp.

SINCLAIR REFINING CO. 289
Marcus Hook, Penna.
Hydrocarbon raw materials:
Catalytic reformate
Petroleum fractions
Refinery gas
Products and output:
Toluene
Paraxylene (98%)
Mixed xylenes
High aromatic solvents
Dodecene
Cresylic acids
Sulfur
Personnel: R. J. Self, mgr.
Remarks: Sales affiliate, Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp.

SINCLAIR REFINING CO. 290
Corpus Christi, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Aromatic solvents
Personnel: E. B. Killick, manager
Remarks: Sales affiliate, Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp.

SINCLAIR REFINING CO. 291
Houston, Texas
Hydrocarbon raw materials:
Petroleum fractions
Refinery gases
Products and output:
Sulfonates (barium, calcium & Sodium salts)
Corrosion inhibitors

Isoparaffinic odorless solvents
Cresylic acids
Sulfur
Personnel: J. D. Seifer, mgr.
Remarks: Sales affiliate, Sinclair Chemicals, Inc., a subsidiary of Sinclair Oil Corp.

SOCONY MOBIL OIL CO., INC. 292
East St. Louis, Ill.
Hydrocarbon raw materials:
Refinery streams
Products and output:
Sodium cresylate solutions
Personnel: H. A. Lutz, mgr; L. J. Keenan, chf engr.

SOCONY MOBIL OIL CO., INC. 293
East Chicago, Ind.
Hydrocarbon raw materials:
Refinery streams
Products and output:
Sodium cresylate solutions
Hydrogen
Personnel: W. W. Reed, mgr; J. W. Mann, oper supt; L. L. Claassen, chf engr.

SOCONY MOBIL OIL CO., INC. 294
Augusta, Kans.
Products and output:
Hydrocarbon fractions
Personnel: H. B. Caldwell, Jr., mgr.

SOCONY MOBIL OIL CO., INC. 295
Trenton, Mich.
Products and output:
Hydrocarbon fractions
Sodium cresylate solutions
Personnel: T. S. Lennox, mgr.

SOCONY MOBIL OIL CO., INC. 296
Paulsboro, N. J.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sodium cresylate solutions
Sodium sulfide solutions
Propylene
Personnel: L. E. Cranston, mgr; H. D. Chapman, oper supt.

SOCONY MOBIL OIL CO., INC. 297
Brooklyn, N. Y.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sodium cresylate solutions
Personnel: D. P. Parker, mgr; F. R. Gohlke, chf engr.

SOCONY MOBIL OIL CO., INC. 298
Buffalo, N. Y.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sodium sulphide
Sodium cresylate solutions
Personnel: T. C. Lockhart, mgr.

SOCONY MOBIL OIL CO., INC. 299
Casper, Wyo.
Products and output:
Hydrocarbon fractions
Petrochemical products
Personnel: E. T. Pummill, mgr.

SOHIO CHEMICAL CO.
Sales subsid. of Standard Oil Co. (Ohio) for Sohio Petroleum Co.

SOHIO PETROLEUM CO. 300
Lima, Ohio
Approximate investment: $18,000,000
Petrochemical raw materials:
Natural gas
Refinery off-gas
Products and output:
Anhydrous ammonia—300 ton/day
Nitric acid
Urea
Carbon dioxide (liquid & solid)
Ammonium nitrate
Nitrogen solutions
Personnel: D. J. Stevens, plt mgr.
Remarks: Subsid of Standard Oil Co. (Ohio)

L. SONNEBORN SONS, INC. 301
Petrolia, Penna.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Sulfonates (oil layer type)
Sulfonates (water soluble)
Coke
Personnel: H. Schindler, mgr; A. W. Straube, chf engr.
Remarks: Coke from Miley-Monsanto-Sonneborn Sludge Decomposition Process.

SOUTHERN NITROGEN CO., INC. 302
Savannah, Ga.
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—90,000 ton/yr
Nitric acid
Urea
Nitrogen solutions
Prilled amonium nitrate
Personnel: J. R. Riley, Pres; R. F. Brown, VP-operations; N. S. Whitaker, prod mgr.
Remarks: Will use gas supplied by Southern Natural Gas Co. of Birmingham, Ala. Plant is scheduled for completion in 1957. Contractor, Girdler Co.

SPENCER CHEMICAL CO. 303
Calumet City, Ill.
Hydrocarbon raw materials:
Methanol
Ammonia
Products and output:
Formaldehyde
Hexamine
Aqua ammonia
Personnel: R. W. McKinnery, mgr; L. T. Landrum, supt.
Remarks: Methanol feedstock comes from Pittsburg, Kans., plant. $120,000 expansion of formaldehyde capacity by Quaker completed Jan. 1957.

SPENCER CHEMICAL CO. 304
Pittsburg, Kans.
Approximate investment: $11,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—178,000 ton/yr
Methanol
Ammoniating solutions
Ammonium nitrate
Nitric acid
Carbon dioxide
Personnel: V. F. Hobart, mgr; W. R. McCluskey, prod supt.

SPENCER CHEMICAL CO. 305
Henderson, Ky.
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Natural gas
Caprolactam
Products and output:
Anhydrous ammonia—79,000 ton/yr
Nitric acid
Ammoniating solutions
Aqua ammonia
Nylon-6 resins
Personnel: R. D. Wallace, mgr; G. Frey, supt.
Remarks: Adding plant to make nylon molding resin. Contr, Quaker; completion summer 1957.

SPENCER CHEMICAL CO. 306
Vicksburg, Miss.
Approximate investment: $14,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—70,000 ton/yr
Ammoniating solutions
Nitric acid—36,500 ton/yr
Urea solutions
Personnel: W. A. Johnston, mgr; J. A. Straub, supt.

SPENCER CHEMICAL CO. 307
Fort Worth, Texas
Products and output:
Liquid carbon dioxide
Dry ice
Personnel: R. R. Severns, mgr.

SPENCER CHEMICAL CO. 308
Orange, Texas
Approximate investment: $12,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Polyethylene—45-million lb/yr
Personnel: E. L. Stevens, mgr.
Remarks: Plan to double capacities for conventional and medium density polyethylene by 1958.
Engineering by company's engrg staff; prime contractor, Quaker Valley Contracts, Inc., Spencer subsid.

STANDARD OIL CO. OF CALIFORNIA 309
El Segundo, Calif.
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Benzene
Toluene
Paraxylene
Cumene
Butadiene-butylene mixtures
Aliphatic acids
Personnel: D. K. Harger, genl mgr.

STANDARD OIL CO. OF CALIFORNIA 310
Richmond, Calif.
Hydrocarbon raw materials:
Natural gas
Petroleum base stocks
Products and output:
Paraxylenes
Orthoxylene
Industrial xylenes
Alkyl aromatic detergents
Metallic naphthenates & naphthenic acids
Cresylic acids
Petroleum sulfonates
Polybutenes
Gas odorants
Ethyl mercaptans
Phthalic anhydride
Phenol—35-million lb/yr
Acetone—20-million lb/yr
Isophthalic acid—50-million lb/yr
Nitric acid—90,000 ton/yr
Metaxylene—5-million lb/yr
Ammonia—100,000 ton/yr
Benzoic-toluic acids—5-million lb/yr
Catalysts
Personnel: C. W. Rehfuss, genl mgr.
Remarks: Paraxylene plant (own design) building, for April 58 completion, feed will be whole xylenes to produce 27-million lb/yr paraxylene. Polybutene plant (own design) building, for July 58 completion, feed will be butenes to produce 2.5 million gal/yr polybutenes.

STANDARD OIL CO. (INDIANA) 311
Wood River, Ill.
Hydrocarbon raw materials:
Heptane heart-cut or Nonene
Products and output:
Issoctyl, decyl or higher alcohols—20-million lb/yr
Polybutene and high molecular wt hydrocarbons
Sodium cresylate
Lube oil detergent and anti-corrosion additives
Petroleum base plasticizers
Personnel: L. H. Butterworth, mgr; S. E. Cahoon, E. A. Jack, asst mgrs; J. K. Roedel, chf engr.
Remarks: Amoco Chemicals Corp. is sales organization.

STANDARD OIL CO. (INDIANA) 312
Whiting, Ind.
Hydrocarbon raw materials:
Petroleum fractions
Refinery gases
Products and output:
Benzene—260,000 bbl/yr
Toluene—450,000 bbl/yr
Xylenes—220,000 bbl/yr
Sulfur—19,250 ton/yr
Detergent alkylate—55-million lb/yr
Sodium cresylate
Personnel: A. F. Endres, mgr; A. H. Hayes, C. H. Dougherty, A. S. Musselman, P. T. Oak, E. G. Whiley, N. T. Robey, asst mgrs; P. L. Krauel, chf engr.
Remarks: Amoco Chemical Corp. is sales organization for these petrochemicals.

STANDARD OIL CO. (INDIANA) 313
Sugar Creek, Mo.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
C_3 olefin concentrate
Personnel: H. R. Boehmer, mgr; J. H. Johnson, I. C. Staeuble, asst mgrs; G. W. Larson, chf engr.
Remarks: Supplies raw material to Wood River OXO alcohol units.

STANDARD OIL CO. (OHIO)
See Sohio Petroleum Co. & Sohio Chemical Co.

STANOLIND OIL & GAS CO.
Now Pan American Petroleum Corp.

STAUFFER CHEMICAL CO. 314
Le Moyne, Ala.
Hydrocarbon raw materials:
Natural gas & sulfur
Products and output:
Carbon disulfide
Personnel: Gordon Mitchell, mgr.

STAUFFER CHEMICAL CO. 315
Dominguez Jct., Calif.
Hydrocarbon raw materials:
Refinery gases
Acid sludge
Hydrogen sulfide
Products and output:
Sulfuric acid
Personnel: W. E. H. Knight, mgr.
Remarks: Building H_2SO_4 plant, for September 1957 completion.

STAUFFER CHEMICAL CO. 316
Hammond, Ind.
Approximate investment: $2,000,000
Hydrocarbon raw materials:
Refinery acid sludge
Products and output:
Sulfuric acid
Personnel: Geo. Schiffbauer, mgr.

STAUFFER CHEMICAL CO. 317
Louisville, Ky.

Approximate investment: $5,000,000
Hydrocarbon raw materials:
Propane—propylene
Natural gas
Products and output:
Carbon tetrachloride
Perchlorethylene
Hydrogen chloride
Chloroform
Methylene chloride
Personnel: H. C. Kutz, plt mgr.
Remarks: New chloroform and methylene chloride unit now operating.

STAUFFER CHEMICAL CO.
(Consolidated Chemical Div.) **318**
Baton Rouge, La.
Hydrocarbon raw materials:
Acid sludge
Hydrogen sulfide
Products and output:
Sulfuric acid—114,000 ton/yr
Sulfur
Personnel: W. J. Daspit, mgr.

STAUFFER CHEMICAL CO.
(Consolidated Chemical Div.) **319**
Baytown, Texas
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Acid sludge
Products and output:
Sulfuric acid—140,000 ton/yr
Personnel: Z. L. Evans, mgr.

STAUFFER CHEMICAL CO.
(Consolidated Chemical Div.) **320**
Houston, Texas
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Acid sludge
Products and output:
Sulfuric acid—140,000 ton/yr
Personnel: O. D. Massey, mgr.

SUN OIL CO. **321**
Toledo, Ohio
Hydrocarbon raw materials:
Refinery streams
Products and output:
Butylenes
Propylene tetramer (Dodecene)
Hydrogen
Personnel: J. F. Harron, mgr; H. C. Thober, supt; J. L. Barker, rfy engr.

SUN OIL CO. **322**
Marcus Hook Penna.
Hydrocarbon raw materials:
Refinery streams
Products and output:
Benzene—19-million
Toluene—30-million gal/yr
Xylene—18-million gal/yr
Petroleum sulfonates
Naphthenic acids
Propylene tetramer (Dodecene)
Propylene trimer (Nonene)
Ammonia—109,500 ton/yr
Sulfur—10,800 ton/yr
Personnel: C. C. Naylor, mgr; W. C. Huffman, supt; F. W. Bowen, rfy engr.

SUNTIDE REFINING CO. **323**
Corpus Christi, Texas
Approximate investment: $10,500,000
Hydrocarbon raw materials:
Naphtha
Propylene
Products and output:
Tetramer—150,000 bbl/yr
Benzene—145,000 bbl/yr
Toluene—325,000 bbl/yr
Xylene—400,000 bbl/yr
Mineral spirits—23,000 bbl/yr
Personnel: J. L. Laird, VP & mgr; J. B. Hutsell, supt; L. W. Plummer, chf engr.
Remarks: Tetramer and mineral spirits in current production. Rexformer, Unifiner and Udex units building, scheduled for completion around mid or late 1957. The investment figure is for all above units.

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TENNESSEE EASTMAN CO. **324**
Kingsport, Tenn.
Hydrocarbon raw materials:
Natural gas or LPG
Also intermediates from Texas Eastman Co., which are in turn derived from hydrocarbon raw materials
Products and output:
Polyethylene wax, Epolene "N"
Dinonyl phthalate
Acrylic textile fiber, Verel
Polymeric plasticizer, NP-10
Personnel: Dr. F. R. Conklin, genl mgr.
Remarks: Commercial facilities for production of new modified acrylic textile fiber to be completed shortly. Verel is produced from intermediates supplied by outside organizations but which are derived from hydrocarbon raw materials.

TEXAS BUTADIENE & CHEMICAL CORP. **325**
Channelview, Texas
Approximate investment: $25,000,000
Hydrocarbon raw materials:
Butanes
Isobutane
Isopentane
Products and output:
Butadiene—86,000 ton/yr
Butylenes
Alkylate
Personnel: K. D. Bowen, mgr; T. H. Pierson, chf engr.
Remarks: Plant was completed Feb. 1957. Can operate for 86,000 ton/yr butadiene or, when producing butylenes for 2.5-million bbl/yr of aviation grade alkylate, butadiene production will be 65,000 ton/yr. Butadiene and butylene made by Houdry dehydrogenation; alkylate by Texaco sulfuric acid alkylation with Stratford Engrg. effluent refrigeration. Butadiene recovery is by Phillips furfural extractive distillation.

THE TEXAS CO. **326**
Lockport, Ill.
Hydrocarbon raw materials:
Refinery gas
Products and output:
Ammonia—180 ton/day
Aqueous ammonia
Nitric Acid
Nitrogen solutions
Personnel: H. A. Lord, supt; R. W. Sanders, supv-chem opers.
Remarks: Under construction. Completion scheduled November, 1957.

THE TEXAS CO. **327**
Port Arthur, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Naphthenic acids
Oil layer type sulfonates
Butylenes
Propylene tetramer
Propylene trimer
Diisobutylenes—8-million lb/yr
Gasoline & furnace oil additives
Lubricating oil additives
Olefin polymers
Ethane-ethylene streams
Propane-propylene mixtures
1-butene, 2-butene mixtures
Heavy hydrocarbons
Rust inhibitors
Personnel: F. L. Wallace, mgr; M. F. Granville, supt of chem opers.
Remarks: Oil additive plant completed Jan. 1957.

TEXAS EASTMAN CO.
(Div., Eastman Kodak Co.) **328**
Longview, Texas
Hydrocarbon raw materials:
Propane
Natural gas
Ammonia
Products and output:
Polyethylene—55-million lb/yr
Ethyl alcohol
Butyraldehydes (normal and iso)
2-Ethyl hexanol
2-Ethyl isohexanol
Isobutyl alcohol
Isobutyronitrile
Neopentyl glycol
Nonyl alcohol
Personnel: D. C. Hull, mgr; W. E. Saunders, supt; W. R. Burton, chf eng.
Remarks: Facilities to make neopentyl glycol on stream Aug. 1957.

TEXAS GAS CORP. **329**
Winnie, Texas
Hydrocarbon raw materials:
Gas liquids condensate

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 139-149. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 360 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

Products and output:
Ethane
Isopentane
Personnel: R. T. Neville, genl plt supt; R. Woolfolk, chf engr.
Remarks: Considering manufacture of ethanol and extraction of pure cyclohexane from gas liquids condensate.

TEXAS GULF SULPHUR CO. **330**
Worland, Wyo.
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—90,000 ton/yr
Personnel: J. W. Estep, mgr.

TEXAS-U. S. CHEMICAL CO. **331**
Port Neches, Texas
Approximate investment: $4,500,000*
Hydrocarbon raw materials:
Butadiene
Styrene
Naphthenic and aromatic extender oils
Products and output:
Butadiene-styrene type synthetic rubber, Synpol—127,000 long ton/yr
Personnel: T. A. McCoy, mgr; J. J. Koch, supt; W. P. Kelly, chf engr.
Remarks: *Purchase price from U. S. Government. Owned 50-50 by The Texas Co. and U. S. Rubber Co. Plant has been expanded from 88,000 long ton/yr at time of purchase to present 127,000 long ton, and will be further expanded to 150,000 long ton/yr by late 1958.

THERMATOMIC CARBON CO. **332**
Sterling, La.
Hydrocarbon raw materials:
Natural gas
Products and output:
Carbon black—100,000,000 lb/yr
Personnel: R. W. Cretney, VP & genl mgr; S. S. Gill, supt; G. W. Temple, chf engr.
Remarks: Since May 1, 1957, has been a division of Commercial Solvents Corp., operating as an autonomous division.

THUNDERBIRD CHEMICALS, INC. **333**
Kyrene, Arizona
Approximate investment: $10,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—40,000 ton/yr
Urea—16,200 ton/yr
Sulfuric acid—61,200 ton/yr
Remarks: In planning stage.
Design and construction under direction of Tellepsen PetroChem Constructors. Area capacity 40,000 ton/yr

TIDEWATER OIL CO. **334**
Delaware City, Del.
Hydrocarbon raw materials:
Sour refinery streams
Products and output:
Sulfur—350 long ton/day (potential)
Personnel: G. C. Caine, mgr; B. G. Jones & M. J. McDonald, asst mgrs; J. J. Mack, chf engr.
Remarks: In operation since Sept. 17, 1956.

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UNION CARBIDE CHEMICALS CO. **335**
Torrance, Calif.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Polyethylene—60-million lb/yr
Ethylene glycol—10-million gal/yr
Ethylene oxide
Personnel: C. N. Rucker, supt.
Remarks: Parent, Union Carbide Corp.

UNION CARBIDE CHEMICALS CO. **336**
Whiting, Ind.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene glycol
Isopropanol
Acetic acid
Acetic anhydride
Acetone
Ethanol
Ethylene oxide
Methyl isobutyl ketone
Personnel: R. T. Bradley, supt.
Remarks: Parent, Union Carbide Corp.

UNION CARBIDE CHEMICALS CO. **337**
Seadrift, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Ethylene glycol
Polyethylene
Ethylene oxide
Butadiene
Monoethanolamine
Diethanolamine
Triethanolamine
Personnel: R. P. Barry, Jr., supt.
Remarks: Increased ethylene capacity to 200-million lb/yr in fall 56. Parent, Union Carbide Corp.

UNION CARBIDE CHEMICALS CO. **338**
Texas City, Texas
Hydrocarbon raw materials:
Natural and refinery gases
Products and output:
Polyethylene—60-million lb/yr
Ethyleneamines
Alcohols
Glycols
Acetone
Acetic acid
Acetic anhydride
Vinyl resins
Acetylene
Acetaldehyde
2-Aminoethyl ethanolamine
Butadiene
n-Butyl acetate
Diethylene triamine
Ethanol
Ethyl acetate
Ethylene dichloride
Ethylene glycol
Ethylene oxide
Isobutanol
Isopropanol
Isopropyl acetate
Methanol
Methyl acetone
Methyl isobutyl ketone
Tetraethylene pentamine
Trichlorethane
Triethylene tetramine
Vinyl acetate
Vinyl chloride
Personnel: T. A. Wilker, supt.
Remarks: Parent, Union Carbide Corp.

UNION CARBIDE CHEMICALS CO. **339**
Institute, W. Va.
Hydrocarbon raw materials:
Natural gas
Other petroleum streams
Products and output:
Acrylonitrile
Acetaldehyde
Acetic acid
Acetic anhydride
Acetone
Acetonitrile
Acetophenone
Acrolein
n-Butyl alcohol
Butyric acid
Butyric anhydride
Diethylene glycol
Diisobutyl ketone
Ethanol
2-Ethylbutanol
2-Ethylhexanol
Ethylene glycol
Ethylene oxide
n-Hexanol
Isophorone
Isopropanol
Mesityl oxide
Methyl acetone
2-Methyl-5-ethyl pyridine
Methyl isobutyl ketone
Paraldehyde
a-Picoline
v-Picoline
Polyethylene
Polyethylene glycols
Plasticizers
Propionic anhydride
Styrene
Trimethyl nonanone-4
2-Ethyl hexanol
Personnel: C. H. Atwood, supt.
Remarks: Doubling acrylonitrile capacity by mid-58. Parent, Union Carbide Corp.

UNION CARBIDE CHEMICALS CO. **340**
So. Charleston, W. Va.
Hydrocarbon raw materials:
Natural gas
Refinery gases
Crude oil
Other petroleum fractions
Products and output:
Acetaldehyde
Acetaldol
Acetoacetanilide
Acetoacet-o-chloranilide
Aceto-acet-o-toluidide
Acetonitrile
Acetophenone
n-Acetyl ethanolamine
Amines
Butadiene
Butoxy ethoxy propanol
n-Butyl acetate
n-Butyl alcohol
N-butyl amine
n-butyl ether
Butyraldehyde
Butyric acid
Butyric anhydride
Crotonaldehyde
Diacetone alcohol
Dibutyl amine
Dichlorethyl ether
Dichlorisopropyl ether
Diethanolamine
Diethyl amine
Diethyl ethanolamine
Diethyl ketone
Diethyl maleate
2,2-Diethyl-1,3-propanediol
Diethyl succinate
Diethyl sulfate
Diethylene glycol
Diethylene glycol monobutyl ether
Diethylene glycol monoethyl ether acetate
Diethylene glycol monoethyl ether
Diethylene glycol dibutyl ether
Diethylene glycol diethyl ether
Diethylene glycol monomethyl ether
Di-2-ethylhexyl adipate
Di (2-ethylhexyl) amine
Di (2-ethylhexyl) maleate
Diisobutyl carbinol
Diisopropanolamine
Dioxane
Dipropylene glycol
Ethyoxytriglycol
Ethyl acetate
Ethyd acetoacetate ethyl acrylate
Ethyl amine
Ethyl butyl ketone
Ethyl ether
Ethyl formate
Ethyl silicate
2-Ethyl 2-butyl-1,3-propanidiol
2-Ethylbutyric acid
Ethylene carbonate
Ethylene chlorhydrin
Ethylene dichloride
Ethylene glycol
Ethylene glycol monobutyl ether
Ethylene glycol monoethyl ether
Ethylene glycol mgnoethyl ether acetate
Ethylene glycol dibutyl ether
2-Ethyl-1,3-hexanediol
2-Ethylhexoic acid
2-Ethyl-hexyl acetate
Glyoxal
2-Ethylhexyl amine
2-Ethylhexyl chloride
Glycol diacetate
Heptadecanol
n-Hexyl ether
Hexylene glycol
Hydroxethyl cellulose
Isobutanol
Isopropanol
Isopropanolamine
Isopropyl acetate
Isopropyl amine
Isopropyl ether
2-Mercaptoethanol
Methanol
Methoxy polyethylene glycols
Methoxy triglycol acetate
Methyl acetone
Methyl amyl acetate
Methyl amyl alcohol
n-Methyl diethanolamine
Methyl isobutyl ketone
Monethanolamine
Nonisopropanolamine
Morpholine
2,4-pentadione-phenyl diethanolamine
Phenyl ethanolamine
Phenyl ethyl ethanolamine
Dioctyl phthalate
Plasticizers
Polyethylene
Polyethylene glycols
Polypropylene glycols
Propionic anhydride
Propylene chlorhydrin
Propylene diamine
Propylene dichloride
Propylene glycol
Propylene oxide
Pyruvic aldehyde
Surface-active agents (Ionics & anionics)
Tetradecanol
Thiodiglycol
Trichlorethane
Triethanolamine
Triethyl amine
Triethylene glycol
Triglycol dichloride
Triisopropanolamine
Trimethy nonanol
Synthetic lubricants
Undecanol
Vinyl resins
Vinyl isobutyl ether
Wetting agents
Personnel: F. H. Belden, genl supt.
Remarks: Parent, Union Carbide Corp.

UNION OIL CO. OF CALIFORNIA **341**
Oleum, Calif.
Approximate investments: $600,000
Hydrocarbon raw materials:
Refinery gases and wastes
Products and output:
Sulfur—18,250 ton/yr
Personnel: M. S. Thomson, mgr.

UNION OIL CO. OF CALIFORNIA **342**
Santa Maria, Calif.
Approximate investment: $1,200,000
Hydrocarbon raw materials:
Refinery and natural gases
Products and output:
Sulfur—30,000 ton/yr (two plants)
Personnel: R. A. McKean, supt. for two sulfur plants here.

UNION OIL CO. OF CALIFORNIA **343**
Wilmington, Calif.
Approximate investment: $1,800,000
Hydrocarbon raw materials:
Refinery gases and wastes
Products and output:
Sulfur—14,000 ton/yr
Ammonium sulfate—20,000 ton/yr
Methyl & ethyl mercaptans—500,000 lb/yr
Personnel: W. T. Jameson, mgr.

UNITED CARBON CO., INC. **344**
Ryus, Kans.
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace blacks
Personnel: Frank Hess, supt.

UNITED CARBON CO., INC. **345**
Franklin, La.
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace blacks
Personnel: M. J. Graham, supt.
Remarks: Adding four reactor production units for a cost of $750,000.

UNITED CARBON CO., INC. **346**
Rayville, La.
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks
Personnel: J. H. Mann, supt.

UNITED CARBON CO., INC. **347**
Eunice, N. Mex.
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks
Personnel: L. L. Eubanks, supt.

UNITED CARBON CO., INC. **348**
Aransas Pass, Texas
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace and channel blacks
Personnel: Frank Gathright, supt.

UNITED CARBON CO., INC. **349**
Falfurrias, Texas
Hydrocarbon raw materials:
Natural gas
Products and output:
Channel blacks

UNITED CARBON CO., INC. **350**
Shamrock, Texas
Hydrocarbon raw materials:
Natural gas and oil
Products and output:
Furnace blacks
Personnel: H. L. Teegerstrom, supt.

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. . . plus descriptions of 360 petrochemicals

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UNITED RUBBER AND CHEMICAL CO. 351
Baytown, Texas
Approximate investment: $8,838,000
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
GR-S rubber—44,000 ton/yr
Personnel: Ted Lyman, mgr & VP.
Remarks: Parent, United Carbon Co.

UNIVERSAL DETERGENTS, INC. 352
Long Beach, Calif.
Approximate investment: $1,200,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Alkyl aryl sulfonates—4320 ton/yr
Aromatic solvents—12,000 bbl/yr
Pitch stock—3500 ton/yr
Resin stock—1000 ton/yr
Personnel: M. Levine, mgr; F. E. Shryock, supt.

U. S. INDUSTRIAL CHEMICALS CO.
(Div., National Distillers and Chemical Corp.) 353
Tuscola, Ill.
Approximate investment: $12,000,000
Hydrocarbon raw materials:
Natural gas streams
Products and output:
Anhydrous ammonia—45,000 ton/yr
Nitrogenous fertilizers
Sulfuric acid—140,000 ton/yr
Phosphatic fertilizer solution (wet process phospheric acid)—30,000 tons P_2O_5/yr
Isosebacic acid—10-million lb/yr
Ammonium nitrate
Nitrogen solutions

U. S. RUBBER CO.
(Naugatuck Chemical Division) 354
Naugatuck, Conn.
Hydrocarbon raw materials:
Butadiene
Styrene
Products and output:
Synthetic rubber S-type—22,200 ton/yr
Styrene Copolymer, Naugatex & Naugapol
Personnel: P. E. Rice, mgr supt; L. A. Doherty, plt engr.
Remarks: Plant capacity being increased 30% in 1957.

U. S. RUBBER CO.
(Naugatuck Chemical Division) 355
Joliet, Ill.
Hydrocarbon raw materials:
Toluene
Products and output:
Explosives
Remarks: Information restricted by government security regulations.

U. S. RUBBER CO.
(Naugatuck Chemical Division) 356
Baton Rouge, La.
Hydrocarbon raw materials:
Butadiene
Styrene
Acrylonitrile
Products and output:
Synthetic rubber N-type, Paracril
Styrene copolymers
Personnel: J. S. Brown, mgr; J. M. Poynter, supt; J. M. Reardon, chf engr.
Remarks: Paracril capacity increased 60% since 1956. Capacity for high impact resins will be increased 50% in 1958.

U. S. RUBBER CO
(Naugatuck Chemical Division) 357
Baton Rouge (Scotts Bluff), La.
Hydrocarbon raw materials:
Butadiene
Styrene
Acrylonitrile
Personnel: J. S. Brown, mgr.
Remarks: Building $5-million plant on 150 acre site, to make Kralastic plastic materials.
Walter Kidde Constructors Inc., doing design and engineering. Louisiana Industrial Services is constructor.

UTAH CHEMICAL CO. 358
Mt. Pleasant, Utah
Approximate investment: $9,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Anhydrous ammonia—54,000 ton/yr
Personnel: N. G. Morgan, Jr., Pres.
Remarks: New plant, still in planning stages.

V & W

VELSICOL CHEMICAL CORP. 359
Marshall, Ill.
Hydrocarbon raw materials:
Petroleum base stocks
Products and output:
Benzen—1°
Toluene
Xylenes
Petroleum polymers
Petroleum resins
Insecticides
Naphthalene
Rubber reclaim oils
Mixed aromatic solvents
Personnel: W. Camp, plt mgr; W. Keyes, prod mgr; A. B. Chadwick, dir of mfg.

VICKERS PETROLEUM CO., INC. 360
Potwin, Kansas
Hydrocarbon raw materials:
Catalytic reformate
Products and output:
BTX aromatics—15-million gal/yr
Personnel: T. Ben Arnold, mgr; F. W. Macfarline, chf engr.
Remarks: Procon, Inc. building $2-million Udex unit at refinery to recover 15-million gal/yr BTX aromatics. Completion scheduled Jan. 1, 1958.

VISCO PRODUCTS CO. 361
Anaheim, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Oil treating chemicals
Personnel: E. T. Kocher, mgr; W. L. Church, chf engr.

VISCO PRODUCTS CO. 362
Sugarland, Texas
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Oil treating chemicals
Personnel: W. H. Kirkpatrick, VP.

WARREN PETROLEUM CORP. 363
Monument, N. Mex.
Approximate investment: $120,000
Hydrocarbon raw materials:
Acid gases
Products and output:
Bulk sulfur—1200 ton/yr
Personnel: L. A. Walker, supt.
Remarks: Parent, Gulf Oil Corp.

WARREN PETROLEUM CORP. 364
Conroe, Texas
Approximate investment: $3,000,000
Hydrocarbon raw materials:
Propane
Products and output:
Formaldehyde—1100 ton/yr
Acetaldehyde—57 ton/yr
Pentaerythritol—1800 ton/yr
Alcohols—1370 ton/yr
Personnel: K. A. Fisher, mgr; Sam Summers, supt.
Remarks: Parent, Gulf Oil Corp.

WARWICK WAX CO., INC. 365
Chanute, Kans.
Hydrocarbon raw materials:
Crude oil sediments
Products and ouput:
Oxidized microcrystalline waxes
Microcrystallines waxes
Wax polymers
Personnel: G. Hatfield, mgr.
Remarks: Parent, Sun Chemical Corp.

WESTVACO CHLOR-ALKALI DIVISION
(Food Machinery & Chemical Corp.) 366
So. Charleston, W. Va.
Hydrocarbon raw materials:
Natural gas
Products and ouput:
Carbon bisulfide
Personnel: N. C. Elphick, mgr; M. E. Birmingham, supt; J. S. Dewick, chf engr.
Remarks: Expansion in progress

WILSHIRE OIL CO. OF CALIFORNIA 367
Norwalk, Calif.

Who Makes What Petrochemicals

For your convenience in locating manufacturers of specific products, turn to pp. 139-149. Products are listed alphabetically with reference numbers corresponding to numbers accompanying each plant item in this directory.

. . . plus descriptions of 360 petrochemicals

In addition to the index, this listing of specific products includes brief technical descriptions of all petrochemicals on which such information is available.

Approximate investment: $175,000
Hydrocarbon raw materials:
H_2S from fuel gas
Products and output:
Sulfur—3,942 ton/yr
Personnel: J. H. Ouding, mgr; L. Earl, supt; S. Lindsey, chf engr.

WITCO CHEMICAL COMPANY 368
Lynwood, Calif.
Hydrocarbon raw materials:
Petroleum naphthenic acid
Products and output:
Metallic naphthenates

WITCO CHEMICAL CO. 369
Chicago, Ill.
Hydrocarbon raw materials:
Petroleum naphthenic acid
Petroleum wax
Asphalt fractions
Products and output:
Metallic naphthenates
Sun checking inhibitors, Sunolite waxes
Rubber extenders
Saturating compounds
Insulating mastics.
Personnel: L. Wood, mgr.

WITCO CHEMICAL CO. 370
Lawrenceville, Ill.
Hydrocarbon raw materials:
Solid petroleum tar
Heavy liquid and semi-solid petroleum fractions
Products and output:
Rubber extenders
Extending plasticizer
Rubber softeners
Personnel: F. C. Collum, supt.

WITCO CHEMICAL CO. 371
Perth Amboy, N.J.
Hydrocarbon raw materials:
Solid petroleum tar
Heavy-liquid semi-solid petroleum fractions
Products and output:
Rubber extenders
Extending plasticizer
Rubber softeners
Personnel: J. R. Burgess, mgr.

WYANDOTTE CHEMICALS CORP. 372
Geismar, La.
Approximate investment: $8,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Ethylene oxide—60-million lb/yr
Ethylene glycol
Diethylene glycol
Personnel: W. A. Oppold, mgr; A. C. Schubring, chf engr.
Remarks: Using Shell Development Co. process. Engineer-contractor is Lummus Co. Company has 1200 acres on the east side of the Mississippi River about 25 miles south of Baton Rouge. Completion due late 1957.

WYANDOTTE CHEMICALS CORP. 373
Wyandotte, Mich.
Approximate investment: $7,000,000
Hydrocarbon raw materials:
Crude oil and fractions
Products and output:
Ethylene glycol
Diethylene glycol
Ethylene dichloride
Chlorinated solvents
Alkyl aryl sulfonate
Synthetic detergents
Sodium carboxy-methyl cellulose
Polyoxalkylene compounds
Chloroethers
Personnel: B. C. Cremers, genl mgr; L. W. Munchmeyer, asst genl mgr; A. C. Schubring, chf engr.
Remarks: Building $3-million oxide products plant to make polyethers for use in polyurethanes and the Pluornic and Tetronic nonionic surface-active agents. Completion due late 1957.
Engr-contr, company engineering dept; constr, J. A. Utley Construction Co.

WYNN OIL CO 374
Azusa, Calif.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil aids
Radiator additives
Fuel additives
Lube oil additives
Personnel: John T. Appelt, mgr.

Petrochemical Plants in Canada

B. A. SHAWINIGAN LTD. 375
Montreal East, Que.
Approximate investment: $4,000,000
Hydrocarbon raw materials:
Cumene
Products and output:
Phenol—20-million lb/yr
Acetone—8-mill on lb/yr
a-Methyl styrene—2-million lb/yr
Isopropanol—4-million lb/yr
Personnel: R. H. Hall, mgr; R. B. Walker, chf engr.

BAKELITE CO.
(Div. of Union Carbide Canada, Ltd.) ... 376
Belleville, Ont.
Hydrocarbon raw materials:
Methanol
Products and output:
Formaldehyde
Phenolic resins
Personnel: F. Perry Wilson, Pres; P. O. Jeffery, VP; J. E. Buchanan, VP—Prod.

BRITISH AMERICAN OIL CO. LTD. 377
Pincher Creek Alberta
Hydrocarbon raw materials:
Natural gas
Products and capacity:
Sulfur—82,000 long ton/yr
Condensate—800,000 bbl/yr
Personnel: C. E. Stewart, supt.
Remarks: In operation since Jan. 31, 1957. Additional capacity planned.

BRITISH AMERICAN OIL CO. LTD. 378
Nevis, Alberta
Hydrocarbon raw materials:
Natural gas
Products and output:
Natural gas (residue)
Butane
Propane

BRITISH AMERICAN OIL CO. LTD. 379
Montreal, Que.
Hydrocarbon raw materials:
Propylene
Benzene
Products and output:
Cumene—36-million lb/yr
Personel: J. W. McHardy, mgr.
Remarks: Cumene is raw material for B. A. Shawinigan.

CABOT CARBON OF CANADA LTD. 380
Sarnia, Ontario
Approximate investment: $4,500,000
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Furnace carbon blacks—60-million lb/yr
Personnel: P. H. Delacour, exec VP; W. F. Hendricks, resident mgr; J. A. Satterfield, supt; A. J. McKenzie, chf engr.

CANADIAN CHEMICAL CO., LTD. 381
Edmonton, Alberta
Approximate investment: $80,000,000
Hydrocarbon raw materials:
Butane
Propane
Natural gas
Products and output:
Propylene glycol
Propylene oxide
Pentaerythritol
Alcohols
Aldehydes
Esters
Ketones
Acetic acid and anhydride
Cellulose acetate
Solvents
Personnel: V. T. Anwyll, mgr; H. K. Busch, prod. mgr; J. C. Langford, chf engr.

CANADIAN HYDROCARBONS, LTD. 382
Winnepeg, Manitoba
Approximate investment: $1,500,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—29,200 ton/yr
Nitrogenous fertilizers—219,000 ton/yr
Remarks: Parent, Winnipeg & Central Gas Co. Plant in planning stage.

CANADIAN INDUSTRIES, LTD. 383
Edmonton, Alberta
Approximate investment: $15,000,000
Hydrocarbon raw materials:
Ethylene
Products and output:
Polyethylene—22.6-million lb/yr
Personnel: S. T. Jones, mgr; G. R. McElroy, works engr.
Remarks: Construction to start this year to double polyethylene capacity.

CANADIAN INDUSTRIES, LTD. 384
Millhaven, Ont.
Approximate investment: $20,000,000
Hydrocarbon raw materials:
Ethylene glycol
Dimethylterephthalate
Products and output:
"Terylene"—11-million lb/yr
Personnel: H. M. Sherwood, mgr; R. B. Wotherspoon, works engr.
Remarks: Parent company is Imperial Chemical Industries, Ltd.

CANADIAN INDUSTRIES, LTD. 385
Millhaven, Ontario
Approximate investment: $9,000,000
Hydrocarbon raw materials:
Residual oil
Products and output:
Anhydrous ammonia—67,000 ton/yr
Personnel: A. A. Perley, prod supt.
Remarks: Plant is under construction by Girdler Co.

CANADIAN OIL REFINERIES, LTD. 386
Corunna, Ontario
Approximate investment: $30,000,000
Hydrocarbon raw materials:
Aromatics
Products and output:
Benzene
Toluene
Xylenes
Hydrogen
Ethane-ethylene
Propane
Butylenes
Aromatic solvents
Personnel: W. M. Norwood, mgr; T. J. Barry, proc supt; T. J. Harvey, chf engr.

CARBIDE CHEMICALS CO.
(Div. Union Carbide Canada Ltd.) 387
Montreal East, Que.
Hydrocarbon raw materials:
Refinery gases
Products and output:
Polyethylene
Anti-freeze, Prestone
Ethylene (captive)
Ethylene oxide
Ethylene glycols
Polyethylene glycols
Glycol ethers
Ethanolamines
Solvents, Cellosolve & Carbitol
Personnel: F. P. Wilson, pres; H. L. Reichart, Jr., VP-prod. & engrg; H. D. Lyon, plt mgr; R. S. Hughes, tech dir.
Remarks: $4-million expansion underway to double original capacity plans for ethylene glycol and polyethylene.

THE CONSOLIDATED MINING AND SMELTING CO. OF CANADA, LTD 388
Calgary, Alberta
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia
Ammonium nitrate fertilizer, Nitraprills—200 ton/day
Personnel: R. S. Woodford, supt.

DOW CHEMICAL OF CANADA, LTD. 389
Sarnia, Ontario
Hydrocarbon raw materials:
Refinery gases
Products and output:
Ethylene
Ethylene oxide
Ethylene glycol
Diethylene glycol
Triethylene glycol
Carbon terachloride
Perchloroethylene
Trichloroethylene
Hydrochloric acid
Ammonia
Styrene monomer
Styrene-butadiene latexes
Polystyrene
Monoethanolamine
Diethanolamine
Triethanolamine
Personnel: P. D. Scott, mfg mgr; J. L. Smart, develop mgr; G. B. MacCoy, chf engr.
Remarks: Increasing ethylene capacity with completion scheduled for fall 1957.

DU PONT CO. OF CANADA, LTD. 390
Maitland, Ontario
Hydrocarbon raw materials:
Cyclohexane
Products and output:
Hexamethylene diamine
Adipic acid
Personnel: A. T. Fell, mgr.

ETHYL CORP. OF CANADA, LTD. 391
Sarnia, Ontario
Approximate investment: $11,000,000
Hydrocarbon raw materials:
Ethane
Ethylene
Products and output:
Anti-knock fluids
Personnel: A. C. Tully, Pres; O. B. Lewis, VP; R. T. Edgar, mgr; E. F. Diedrich, asst mgr; C. L. Weeks, chf engr.
Remarks: New plant started operations Sept. 1956.

B. F. GOODRICH, CANADA, LTD. 392
Thorold Township, Ontario
Approximate investment: $3,500,000
Products and output:
Polyvinyl chloride, Geon
Personnel: H. R. Pletch, mgr; E. Clayson, supt; D. Brooks, plt engr.
Remarks: Operations began Feb. 1957.

IMPERIAL OIL LTD. 393
Sarnia, Ont.
Approximate investment: $5,000,000
Hydrocarbon raw materials:
Petroleum gas
Liquid fractions
Products and output:
Ethylene
Propylene
n-Butylenes
Butadiene
Aromatic distillates
Dodecyl benzene—30-million lb/yr
Tripropylene
Tetrapropylene
Personnel: G. R. McMillin, mgr.
Remarks: Dodecyl benzene alkylate plant building by Fluor Corp. of Canada. To start up Sept. 1957. Primary petrochemicals plant building, Canadian Bechtell, Ltd., builder.

INLAND CHEMICALS OF CANADA, LTD. 394
Fort Saskatchewan, Alberta
Approximate investment: $1,000,000
Hydrocarbon raw materials:
Sulfur
Products and output:
Sulfuric acid—36,500 ton/yr
Personnel: G. S. Grant, mgr; S. M. Sumka, supt.
Remarks: Sulfur comes from Shell at Jumping Pound.

JEFFERSON LAKE SULPHUR CO. 395
Ft. St. John, B. C.
Approximate investment: $1,800,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—108,000 ton/yr
Remarks: A joint operation with Pacific Petroleums Ltd. Plant will operate on gas feed from Pacific's new natural gasoline plant being built at Ft. St. John. Completion date: 1957.

LAURENTIDE CHEMICAL & SULFUR CO. 396
Montreal East, Quebec
Hydrocarbon raw materials:
Sour refinery gases
Products and output:
Sulfur—33,000 long ton/yr
Personnel: J. H. Fulmer, mgr; D. G. Zink, pres.
Remarks: $1.25-million plant being built by Proctor Engr. Co., Tulsa, Okla. Refinery gases from refineries in Montreal East.

LUBRIZOL OF CANADA, LTD. 397
Niagara Falls, Ont.
Hydrocarbon raw materials:
Petroleum fractions
Products and output:
Lube oil additives
Personnel: M. A. Payne, mgr.

MONSANTO CANADA, LTD. 398
Montreal, Que.
Hydrocarbon raw materials:
Petroluem base stock
Products and output:
Polystyrene
Oil additives

S. NORD CHEMICAL CO. 399
Petrolia, Ontario
Approximate investment: $1,500,000
Hydrocarbon raw materials:
Catalytic reformate
Products and output:
Benzene
Toluene
Xylenes
Total B-T-X—30-million gal /yr
Naphthas
Personnel: Sol Nord, mgr.

NORTHWEST NITRO-CHEMICALS LTD. 400
Medicine Hat, Alberta
Approximate investment: $22,000,000
Hydrocarbon raw materials:
Sulfur from natural gas
Natural gas
Products and output:
Nitrogenous fertilizers
Personnel: C. W. Hancock, mgr; G. B. Brown, chf engr.

POLYMER CORP., LTD. 401
Sarnia, Ont.
Approximate investment: $83,000,000
Hydrocarbon raw materials:
Refinery gases
Products and output:
Styrene monomer
Ethylene
Isobutylene
Butyl & butadiene rubbers, Polysar
Personnel: E. R. Rowzee, mgr; L. D. Dougan, plt mgr; E. W. Skelton, chf engr.

POLYMER CORP. LED. 402
Western Canada (In Deer River Area)
Hydrocarbon raw materials:
Natural gas
Butane
Products and output:
Butadiene
Synthetic rubber
Remarks: Poymer is considering new butadiene facilities in Western Canada, and such consideration is related to the supply of butane which may become available as a result of Trans-Canada pipe line. Still in planning stage. Owned by Canadian Governmnt.

QUEBEC AMMONIA CO. LTD. 403
Maitland, Ont.
Approximate investment: $8,500,000
Hydrocarbon raw materials:
Fuel oil
Products and output:
Ammonia—43,800 ton/yr
Remarks: Plant is to ultimately operate on natural gas when it becomes available. In planning stage.

ROYALITE OIL CO., LTD. 404
Turner Valley, Alberta
Approximate original investment: $3,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—14,400 tons
Personnel: E. F. Stevens, mgr; C. J. Pearson, supt; R. Couteret, chf engr.

ST. MAURICE CHEMICALS CO. 405
Varennes, Que.
Hydrocarbon raw materials:
Methanol
Acetaldehyde
Products and output:
Formaldehyde—30-million lb/yr
Pentaerythritol—3-million lb/yr
Personnel: Hal Norton, manager
Remarks: Parent companies are Shawinigan Chemicals Co. and Heyden Newport Chemical Corp.

SHELL OIL CO. OF CANADA, LTD. 406
Jumping Pound, Alberta
Approximate investment: $1,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulfur—28,800 long ton/yr
Natural gas—60 MMCF/D
Personnel: J. M. Dillion, Mgr; K. A. Sorenson, supt.

SHELL OIL CO. OF CANADA, LTD. 407
Montreal, Que.
Approximate investment: $4,500,000
Hydrocarbon raw materials:
Butylene
Propylene
Benzene
Products and output:
Isopropyl alcohol
Acetone
Total alcohol & acetone—35-million lb/yr
Methyl ethyl ketone
Secondary butanol
Total methyl ethyle ketone and secondary butanol—4.5-million lb/yr
Detergent alkylate
EPON resins
Personnel: J. L. Miller, mgr; J. E. Nichol, chem plt supt; J. S. Ball, chf engr.
Remarks: Isopropyl alcohol and acetone in operation since Feb. 1953. SBA and MEK plant on stream early 1957. Detergent alkylate and EPON resins plants by Refinery Engineering Ltd. to be completed early 1958. Current expansion will add $5-million to total investment.

SHERRITT GORDON MINES, LIMITED (Chemical Metallurgical Div.) 408
Fort Saskatchewan, Alberta
Approximate investment: $25,000,000
Hydrocarbon raw materials:
Natural gas
Products and output:
Ammonia—1000 ton/yr (net)
Ammonium sulfate—90,000 ton/yr
Personnel: W. H. Young, manager C. A. Hames, V. N. McKim, assistant managers

SUN OIL CO., LTD. 409
Sarnia, Ont.
Hydrocarbon raw materials:
Refinery streams
Products and output:
Butylenes
Hydrogen
Personnel: G. R. Henderson, manager; F. A. Bain, supt; P. Monsen, mech supvr.

SURPASS PETROCHEMICALS LTD. 410
Toronto, Ontario
Remarks: Parent, Montgary Explorations, Ltd.

TEXAS GULF SULPHUR CO. & DEVON-PALMER OILS, LTD. 411
Okotoks, Alberta
Hydrocarbon raw materials:
Natural gas
Products and output:
Sulphur—300 long t/d
Remarks: Completion is expected in May, 1959.

Which Plants Make What Petrochemicals?

THE FOLLOWING PAGES will make your 1957 Petrochemical Plant Survey more helpful. Starting below is a glossary of over 350 important petrochemical products as well as an index to the plant survey of the preceding 18 pages.

You will find this material useful in two ways:

1—You can learn who makes what products in which plants. Code numbers following the name of each material correspond to numbers following the listing for each plant in the directory. If you want to know who is making acetaldehyde, for example, look for "acetaldehyde" in the glossary. Use the numbers shown in referring back to the plant listings.

2—You can learn more about the material itself—its chemical composition, principal physical properties, how it's made, and where it's used. Physical properties have been abbreviated for convenience: BP means boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

Three points should be kept in mind when the glossory is used:

1—This is not a markets listing. Many materials reported by the manufacturers are not for sale. They are only captive, or intermediate, products.

2—The code system for locating manufacturing plants is based on the survey itself. This survey is based only on information reported to PETROLEUM PROCESSING by the individual companies. Because some firms prefer not to report all specific products, no claim can be made for the completeness of this glossary with respect to all manufacturers.

3—It was not the intention of PETROLEUM PROCESSING's Editors to make this glossary a complete chemical history. We are reporting only the petrochemical routes to the products, and we have ignored most of the non-petroleum sources (e.g., coal tar for benzene).

ACETAL (Diethylacetal, Diethylaldehyde)—

$CH_3CH(OC_2H_5)_2$. Colorless liq. BP 216°F (102.2°C), D 6.89 lb/gal. Made by partial oxidation of ethyl alcohol, with first-formed acetaldehyde condensing with the alcohol. Used as general solvent; chemical intermediate.

ACETALDEHYDE (Ethanal, Ethyl Aldehyde)—20, 44, 45, 338, 339, 340, 364

CH_3CHO. Colorless liq. BP 68.4°F (20.2°C), FP −190.3°F (−123.5°C), SG 0.783 (18/4°C). Made by dehydrogenation or oxidation of ethyl alcohol; oxidation of propane or butane; or water-acetylene reaction. Used to mfr. acetic acid and anhydride, n-butyl alcohol, 2-ethylhexanol, paraldehyde, pentaerythritol and subsititued pyridines; phenolic resins, synthetic rubber.

ACETIC ACID (Methanecarboxylic Acid)—20, 44, 45, 336, 338, 339, 381

CH_3COOH. Colorless liq. BP 244.6°F (118.1°C), MP 61.9°F (16.6°C), D 8.64 lb/gal (20°C). Made by acetaldehyde or hydrocarbon gas oxidation. Used to mfr. acetic anhydride synthetic fibers, plastics, synthetic rubber coagulation; acidifying agent; solvent.

ACETIC ANHYDRIDE (Acetyle Oxide, Acetic Oxide)—45, 336, 338, 339, 381

$(CH_3CO)_2O$. Colorless liq. BP 283.8°F (139.9°C), FP −90.4°F (−68°C), den. 9.0 lb/gal (20°C). Made by acetaldehyde oxidation; from acetylene via ethylidene diactate from acetylene-acetic acid reaction; ketone-acetic acid reaction; or distilling acetyl chloride with sodium acetate. Used to mfr. acetate rayon, cellulose acetate products.

ACETONE (Dimethylketone, Propanone)—2, 20, 44, 122, 163, 310, 336, 339, 375, 407

CH_3COCH_3. Colorless liq. BP 133°F (56.1°C), MP −137.7°F (−94.3°C), den. 6.64 lb/gal

(15°C). Made by isopropyl alcohol oxidation; or acetylene-water reaction. Used as solvent; to mfr. plastics, surface coatings, adhesives; wax purification; aerosol component; acetylene absorbent.

ACETONE CYANHYDRIN (Acetone cyanohydrin)—263

$(CH_3)_2COHCN$. Colorless liq. BP 179.6°F (82° C at 23 mm Hg), FP −4°F (−20°C), SG 0.932 (19°C). Made by acetone-hydrocyanic acid condensation. Used as insecticide; to mfr. methyl methacrylate.

ACETOPHENONE (Phenylmethyl Ketone, Acetyl Benzene)—163, 339, 340

$C_6H_5COCH_3$. Colorless liq. or transparent crystals. BP 395.6°F (202°C), MP (congealing) 66.2°F (19.9°C), SG 1.026. Made by ethylbenzene oxidation or benzene-acetic anhydride or benzene-acetyl chloride reactions. Used as cellulose resin solvent; corrosion inhibitors. Potential use in synthetic resins and rubbers; solvent coating vinyl.

ACETYLENIC GLYCOLS (see "Surfynols")

ACETYLENE (Ethine, Ethyne)—13, 193, 338

CHCH. Colorless gas. BP −119.2°F (−84°C), SG 0.91. Made by natural gas or hydrocarbon pyrolysis. Used in German "Reppe Chemie" reactions; to mfr. vinyl chloride, Neoprene synthetic rubber, trichorethylene, acrylonitrile, vinyl acetate, acetylene black, electrically-conductive rubber and plastics.

ACROLEIN (Acraldehyde, Allyl Aldehyde, Acrylic Aldehyde, Propenal)—275, 339

CH_2CHCHO. Colorless-to-yellow liq. BP 126.5° F (52.5°C), MP −125.9°F (−87.7°C), SG 0.84. Made by propylene oxidation; from propylene via production and allyl alcohol oxidation; or glycercine dehydrogenation. Used as extraction solvent; for mfr. of many not-yet-commercial chemicals. Potential uses as mfr. glycerine, methionine, plastics.

ACRYLAMIDE

$CH_2CHCONH_2$. Colorless crystals. BP 257°F (125°C at 25 mm Hg), MP 184.1°F (84.5°C), SG 1.122 (30°C). Made by hydration of acrylonitrile with sulfuric acid, followed by neutralization. Uses: chemical intermediate, esp. for dyes; in mfr. of plastics, adhesives, sizes for textiles and papers, soil conditioners.

ACRYLONITRILE (Propenenitrile, Vinyl Cyanide)—13, 186, 193, 339

CH_2CHCN. Colorless liq. BP 171.3°F (77.4°C), MP −117.4°F (−83°C), Dens. 6.7 lb/gal (20°C). Made from ethylene and hydrogen cyanide via mfr. and dehydration of ethylene cyanohydrin; or acetylene-hydrogen cyanide reaction. Used to mfr. Buna-N rubber, plastics, synthetic fibers, polyacrylonitriles, amines or acids. Potential use in cyanoethylation of cotton.

ADDITIVES (Cutting Oil)—209, 210, 211, 217, 286, 311, 327

Organic sulfur, chlorine, or phosphorous compounds added to mineral oils to reduce friction at the chip-tool interface in relatively low-speed, heavy-duty metal-cutting operations.

ADDITIVES (Lubricating Oils)—32, 43, 121, 122, 181, 182, 198, 207, 217, 246, 270, 286, 311, 327, 374, 397, 398

Organic chemicals, derived from petroleum, added to lubricating oils to act as boundary lubricants, detergents or dispersants, extreme-pressure agents, emulsifiers, foam depressants, oxidation inhibitors, polymeric thickeners or viscosity-index improvers, pour-point depressants, rust preventives, or wear-inhibitors.

ADIPIC ACID (Butanedicarboxylic Acid, Hexanedioic Acid)—114, 390

$COOH(CH_2)_4COOH$. Colorless-to-yellowish cryst. BP 509°F (265°C) (100 mm Hg), MP 305.6°F (152°C), SG 1.360 (20/4°C). Made by cyclohexane oxidation (directly or via synthesis of cyclohexanone or cyclohexanol); via phenol hydrogenation to cyclohexanol; or from butadiene. Used to mfr. nylon hexamethylene diamine, adipates, polyurethanes, plastics, resins and synthetic rubber.

ADIPONITRILE (Hexanedinitrile, 1, 4-dicyanobutane)—112

$CN(CH_2)_4CN$. Colorless liq. BP 582.8° (306° C). SG 0.962 (20/4°C). Made by 1; 4-dichlorobutane-sodium cyanide reaction, or passing ammonia through adipic acid in presence of phosphates. Used to mfr. hexamethylene diamine (for nylon mfr).

ALCOHOLS—311, 328, 338, 339, 340, 364, 381

ROH, (R is hydrocarbon radical) whether aliphatic, alicyclic, or aromatic-aliphatic. Only one hydroxyl group (OH) may be attached to one carbon atom, but molecule may have several hydroxyl groups (polyhydric alcohols). Colorless liquids or solids, depending on type. Made by paraffinic hydrocarbons oxidation, or olefnic hydrocarbons hydration, or synthesis from carbon monoxide and hydrogen. Used as solvents, chemical intermediates, etc.

ALDEHYDES—338, 339, 340 381

RCHO (R is any hydrocarbon radical). Liquids or solids, except formaldehyde (a gas). Made by alcohol oxidation or dehydrogenation, or olefins oxidation, or glycol oxidation. Used as chemical intermediates.

ALDRIN — (Hexachloro-hexahydro-dimethanonaphthalene)—274

$C_{12}H_6Cl_6$. White cryst. solid. MP 219.2-220.1°F (104-104.5°C). Made from petroleum-derived naphthalene. Used as insecticide.

ALIPHATIC ACIDS—309

RCOOH (R is an aliphatic hydrocarbon radical). E. g., see Acetic acid, Propionic acid. Made by alcohol or aldehyde oxidation; or ester, amide, acid chloride, nitrile, or acid anhydride. Used as chemical intermediate.

ALIPHATIC NAPHTHAS

Open-chain petroleum hydrocarbon fractions. Various naphthas have different boiling ranges; e.g., ligroin or petroleum ether boils 68-275°F, dry-cleaning solvent boils over 300-400°F range. From fractionation or extraction of paraffinic or mixed-base crudes. Used as solvents, paint thinners.

ALKYL AROMATIC DETERGENTS, see Sulfonated alkyl benzenes—23

ALKYL ARYL SULFONATES, see Sulfonated alkyl benzenes—5, 352, 373

ALKYLATE (Detergent)—206, 310, 312

$C_{12}H_{25}C_6H_5$, dodecylbenzene. Made by benzene-dodecene alkylation. Used to mfr. synthetic detergents. See also Sulfonated alkyl benzene.

ALKYLATE (Gasoline)—325

C_8H_{18}, isomeric octanes. Colorless liquids. BP in C_8 gasoline range. Made by isobutane-butylene alkylation. Used as high-octane gasolines component.

ALKYLATED CRESOLS—177

$(R)_nC_6H_{3-n}OH$ (R is alkyl group). E.g., di-tert-butyl-p-cresol, colorless solid, BP 509°F (265°C), MP 158°F (70°C). Made by cresol alklation. Used as antioxidant for lubricating oils and rubber, stabilizer for cracked gasolines.

ALLYL ALCOHOL (Propenyl alcohol, 2-propen-1-ol)

CH_2CHCH_2OH. Colorless liquid. BP 206.4°F (96.9°C), FP-200.2°F (-129°C), SG 0.852-0.855, D 7.11 lb/gal. Made from propylene via mfr. and hydrolysis of allyl chloride, from propylene oxide, or by dehydration of propylene glycol. Used in mfr. of plastics, perfumes, flavorings, pharmaceuticals; in denaturing ethyl alcohol.

ALLYL CHLORIDE (3-Chloropropene)—275, 276

CH_2CHCH_2Cl. Colorless liquid. BP 113°F (45°C), FP-210.1°F (-134.5°C), SG 0.935-0.939, D 7.83 lb/gal. Made by chlorination of propylene. Used as chemical intermediate, esp. for alkyl alcohol; in mfr. plastics, varnishes, adhesives.

ALPHA METHYL STYRENE (Vinyltoluene Isomer)—101

$C_6H_5C(CH_3)CH_2$. Colorless liq. BP 329.7°F (165.38°C), MP —9.8°F (—23.21°C), SG 0.9062 (25/25°C). Made by ethylene-toluene alkylation with dehydrogenation of side chain; toluene-acetylene reaction; or benzene and propylene via cumene which is then dehydrogenated. Used to synthesize nitric acid, ammonium nimonomer for resins and synthetic fibers. Possible use as substitute for benzene derived styrene in synthetic rubber mfr.

2-AMINO-2-METHYL-1,3-PROPANEDIOL (Butanediolamine, Aminobutylene glycol)

$CH_2OHC(CH_3)NH_2CH_2OH$. White Crystals. BP 304-306°F (151-52°C) at 10 mm, MP 228-232°F (109-111°C). Used as chemical intermediate, emulsifying agent, solvent.

2-AMINO-2-METHYL-1-PROPANOL (Isobutanolamine)

$CH_3C(CH_3)NH_2CH_2OH$. Colorless liquid or white crystals. BP 329°F (165°C) at 10 mm, MP 86-88°F (30-31°C), SG 0.934, D 7.76 lb/gal. Used as chemical intermediate, emulsifying agent, absorbent for acid gases.

AMMONIA—6, 7, 9, 13, 22, 23, 25, 40, 41, 51, 53, 55, 71, 86, 90, 119, 151, 160, 161, 189, 190, 194, 195, 208, 216, 234, 236, 238, 264, 265, 271, 273, 300, 302, 303, 304, 305, 306, 310, 322, 326, 333, 353, 358, 382, 385, 388, 389, 403, 408.

NH_3. Colorless gas or liq. BP —28.1°F (—33.4°C), MP —107.9°F (—77.7°C), SG (gas) 0.5971, SG (liq) 0.817 (—79°C). Made by reaction of hydrogen and nitrogen, with hydrogen from natural-gas or from catalytic reforming. Used to synthesize nitric acid, ammonium nitrate, ammonium sulfate, hydrazine, sodium cyanide, etc.; as refrigerant, fertilizer or in fertilizer mfr.; in rubber vulcanization, petroleum refining, in production of synthetic fibers (e. g., rayon and nylon); and as resin-condensing agent.

AMMONIATING SOLUTIONS—71, 304, 305, 306

Solutions containing ammonia, ammonium nitrate, and/or urea. Made by mixing aqua ammonia with ammonium nitrate and/or urea. Used to ammoniate superphosphate in the preparation of mixed fertilizer.

AMMONIUM NITRATE—9, 40, 51, 71, 86, 119, 189, 190, 194, 195, 234, 264, 300, 302, 304, 353, 388

NH_4NO_3. Colorless or white solid. Decomposes at 410°F (210°C), MP 337.3°F (169.6°C), SG 1.725. Made from ammonia-nitric acid reaction in aqueous ammonium nitrate solution. Used as fertilizer; to mfr. nitrous oxide; as nitrogen oxide absorbent; and to prod. insecticides.

AMMONIUM PHOSPHATE (Ammonium acid phosphate)—51, 52

$NH_4H_2PO_4$. White powder or colorless-to-white crystals. SG 1.803. Made by ammonia-phosphoric acid reaction. Used in fertilizers, fireproofing.

AMMONIUM SULFATE—13, 40, 53, 135, 194, 236, 281, 343

$(NH_4)_2SO_4$. White to brownish-gray crystals. MP 955.4°F (513°C) (decomp.), SG 1.77. Made from ammonia—conc. sulfuric acid reaction. Used as fertilizer; as fireproofing agent; in water treatment; and in prod. of textiles (viscose silk).

AMYL ACETATES (Banana oil, Pear oil, Amylacetic ester)—225, 226

$CH_3COOC_5H_{11}$. Colorless liq. isomers range in BP from about 255.2°F (124°C at 740 mm. Hg) to 299.1°F (148.4°C at 737 mm), in MP from —95.4°F (—70.8°C) to —109.3°F (—78.5°C), SG 0.87-0.88. Made from amyl alcohols—acetic acid esterification, or fusel oil (principally isoamyl alcohol)—sodium acetate reaction. Used as solvent to mfr. nitrocellulose, rayons, celluloid and celluloid cements, lacquers, varnishes, waterproofing compounds.

AMYL ALCOHOLS (Butyl carbinols)—225, 226

$C_5H_{11}OH$. Colorless liq. Isomers range in BP from 215.6°F (102°C) to 280.4°F (138°C) in MP from 127.4°F (53°C) to —178.6°F (117°C), SG from 0.809 to 0.824. Made from pentane chlorination followed by alkaline hydrolysis. Used to mfr. amyl acetate, lacquer solvents, plasticizers, petroleum products; additives as solvents for oils, resins, sulfur, phosphorus, spirit varnishes, dyestuffs; in rubber vulcanization.

AMYL CHLORIDES (Chloropentane isomers)—225, 226

$C_5H_{11}Cl$. Straw-to-deep purple liq. BP 185-228°F (85-109°C); SG 0.88 (20°C), D 7.33 lb/gal. Made by mixed pentanes chlorination. Used to mfr. other amyl compounds, rubber cements; as solvent.

AMYL MERCAPTAN (Pentanethiol isomers, mixed)—226

$C_5H_{11}SH$. Colorless-to-light yellow liq. BP 219-266°F (104-130°C), SG 0.83-0.84, D 6.99 lb/gal. Made by mixing amyl bromide or amyl chloride with potassium hydrosulfide in alcohol.

Used to mfr. organic sulfur compounds; as natural gas odorant.

AMYL NAPHTHALENES (Mixed isomers)—225, 226

$C_{10}H_7C_5H_{11}$. Yellow-to-brown liq. BP 550-692°F (288-367°C), SG 0.94-0.96 (20°C). Made by alkylating naphthalene with normal pentenes and amyl chloride. Used as high-boiling solvent, constant-temperature bath medium; to mfr. textile chemicals, resin plasticizers, asphaltic materials.

AMYL PHENOL, o-sec.—225, 226

$C_5H_{11}C_6HOH$. Straw-colored solid. BP 455-482°F (235-250°C), SG 0.955-0.971 (20/20°C), D 8.0 lb/gal. Made by phenol-n-pentenes alkylation. Used in paints as dispersing, mixing, antiskinning agent; to mfr. chemicals.

AMYL PHENOL, o-tert.

$(CH_3)_2C_2H_5CC_6H_4OH$. Pale yellow solid. BP 451-473°F (233-245°C), SG 0.96-0.97 (30° C), D 8.12 lb/gal. Made by phenol-mixed pentenes sulfuric acid alkylation. Used in paint mfr. as dispersing, mixing, antiskinning agent; to mfr. chemicals.

AMYL PHENOL, p-tert.

$(CH_3)_2C_2H_5CC_6H_4OH$. White cryst. BP 509-513°F (265-267°C), MP 199°F (93°C), SG 0.91-0.94 (95°C). Made same as o-tert-amyl phenol, or phenol-tert-amyl alcohol reaction in sulfuric acid. Used as intermediate for oil-soluble phenol-formaldehyde resins, chemicals; as plasticizer.

ANHYDRIDES (acid anhydrides)—339

RCOOCOR or $(RCO)_2$ (R is hydrocarbon group). E.g., acetic anhydride, maleic anhydride, and phthalic anhydride. Made generally by condensation of acid chloride with sodium salt of the acid, the acid chloride made from the sodium salt by reaction with phosphorus oxychloride. Used as chemical intermediates, esp. for acids.

ANTIKNOCK FLUIDS—105, 123, 124, 391

Chemical mixtures containing tetraethyl lead, $Pb(C_2H_5)_4$, as the knock-inhibiting ingredient, and ethylene dichloride and/or ethylene dibromide as scavengers of the lead products formed on combustion. Made by treating lead-sodium alloy with ethyl chloride. Used as an antiknock additive in gasolines.

AROMATIC AND ALIPHATIC SOLVENTS—170, 203, 204, 227

Petroleum naphthas, either aromatic or aliphatic. Boiling generally somewhere in the gasoline range. From fractionation or extraction of virgin or refined crudes. Aromatic solvents available from reformed naphthas. Used as solvents.

AROMATIC DISTILLATE—156, 172, 222, 393

Hydrocarbon fraction containing high proportion of aromatics, such as benzene, toluene, and the xylenes. From fractionation and/or extraction of high-aromatic-content crude fractions or reformed naphthas. Used as high-octane gasoline component, solvent; to mfr. detergents.

AROMATIC FRACTIONS, see Aromatic distillate—222, 245, 386

AROMATIC MIXTURES, see Aromatic distillate —83, 359, 360

AROMATIC TARS—120

Heavy viscous liquids, brown to black in color, with high aromatic and condensed aromatic hydrocarbon content. Made by destructive distillation, severe cracking, or coking of petroleum. Used as aromatic hydrocarbon source; to mfr. tar-based products.

BENZENE (Benzol)—16, 26, 48, 80, 81, 83, 88, 91, 116, 120, 133, 153, 180, 278, 280, 309, 312, 322, 323, 359, 386, 399

C_6H_6. Colorless liq. BP 176.2°F (80.1°C), MP 42°F (5.56°C), SG 0.879 (20/4°C), D 7.32 lb/gal. Made by catalytic reforming of naphthalenes in petroleum naphthas. Used to mfr. phenol, styrene, nylon, detergents, aniline, maleic anhydride, phthalic anhydride, dephenyl, nitrobenzene, chlorobenzenes; as solvent, component of high-octane gasoline, varnishes, lacquers.

BENZENE HEXACHLORIDE (Hexachlorocyclohexane)—55, 95

$C_6H_6Cl_6$. Tech. prod. (stereoisomers mixt.) white-to-yellowish solid. MP gamma isomer (lindane) 234°F (112°C). Made by photochemical benzene chlorination. Used as insecticide.

BENZENE SULFONYL CHLORIDE (Benzene sulfonic chloride)—92

$C_6H_5SO_2Cl$. Amber liq. BP 484.7°F (251.5°C), FP 58.1°F (14.5°C), SG 1.3842 (15°C). Made by sodium benzenesulfonate-phosphorus pentachloride reaction. Used as chemical intermediate, esp. to mfr. benzene sulfonamide plasticizer.

BIS(2-ETHYLHEXYL)2-ETHYLHEXYLPHOSPHONATE

$C_8H_{17}P(O)(OC_8H_{17})_2$. Colorless liquid. BP 320-322°F (160-1°C) at 0.25 mm, SG 0.908. Used as chemical intermediate, in mfg. of surface-active agents, antistatic agents, antioxidants, pesticides.

BISPHENOL A—276

$HOC_6H_4C(CH_3)_2C_6H_4OH$. White-to-brown flaky solid. BP 428°F (220°C), FP 302-307.4°F (150-153°C). Made by acetone-phenol condensation. Used as chemical intermediate: to mfr. epoxy resins, paints, glass-reinforced plastics, adhesives, oil-soluble phenolic resins.

BUTADIENE (1, 3-Butadiene, Vinylethylene)—10, 87, 101, 104, 120, 129, 170, 186, 202, 212, 228, 229, 232, 272, 309, 325, 337, 338, 340, 393, 402

$CH_2CHCHCH_2$. Colorless gas. BP 24.1°F (—4.41°C), FP —164°F (—108.9°C), SG 0.6211 (20°C). Made by n-butylenes or n-butane dehydrogenation, or ethyl alcohol dehydrogenation to acetaldehyde and subsequent reaction of acetaldehyde with excess alcohol, or from acetylene by Reppe process. Used to mfr. synthetic rubber (GR-S or Buna S with styrene, butyl with isobutylene).

BUTANOL (n-Butyl alcohol, Propyl carbinol)—44, 339, 340

$CH_3CH_2CH_2CH_2OH$. Colorless liq. BP 243.9°F (117.7°C), FP —111.8°F (—79.9°C), SG 0.810 (20/4°C), D 6.75 lb/gal (20°C). Made by condensing acetaldehyde to aldol, dehydration of aldol to crotonaldehyde, and hydrogenation of latter to n-butanol; or by high pressure butane oxidation. Used as solvent; to mfr. esters, rayon, lacquers, cleaning solutions, paint removers, plastics, paints, varnishes, and enamels.

sec-BUTANOL (Butanol-2, sec-Butyl alcohol, Methylethylcarbinol)—122, 407

$CH_3CH_2CHOHCH_3$. Colorless liq. BP 211.1°F (99.5°C) FP —174.5°F (—114.7°C), SG 0.808 (20/4°C) D 6.74 lb/gal. Made by butylenes absorption in sulfuric acid, followed by hydrolysis of resulting butyl sulfates. Used to mfr. methyl ethyl ketone; as lacquer solvent and thinner.

tert-BUTANOL (Trimethyl carbinol)

$(CH_3)_3COH$. White crystals. BP 181°F (82.8°C), MP 77.9°F (25.5°C), SG 0.7887 (20/4°C). Made by isobutylene-sulfuric acid reaction followed by hydrolysis of resulting sulfate. Used as solvent, ethyl alcohol denaturant; to mfr. chemicals, resins; as lubricants stabilizer.

3-n-BUTOXYPROPIONIC ACID

$CH_3(CH_2)_3OCH_2CH_2COOH$. Liquid. BP 237°F (114°C) at 4 mm, MP 32°F (0°C), SG 0.989. (114°C) at 4 mm; MP <32°F (0°C), SG Uses largely unknown as yet.

BUTYL ACETATE—44, 338, 340

$CH_3COOCH_2CH_2CH_2CH_3$. Colorless liq. BP 259.7°F (126.5°), MP —106.2°F (—76.8°C), SG 0.882 (20°C), D 7.29 lb/gal. Made by n-butyl alcohol-acetic acid esterification. Used as solvent for natural and synthetic resins; to mfr. lacquers, pyroxylin solutions, plastics, safety glass.

sec-BUTYL ACETATE (2-Butanol acetate)—122

$CH_3COOCH(CH_3)CH_2CH_3$. Colorless liq. BP 234°F (112.2°C), SG 0.870 (20/4°C), D 7.18 lb/gal. Made by sec-butyl alcohol-acetic acid esterification. Used as nitrocellulose solvent to mfr. lacquers, thinners, celluloid products.

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

BUTYL-2, 4-DICHLOROPHENOXYACETATE—40

Weedkiller made by esterification of 2, 4, -D (2, 4-dichlorophenoxyacetic acid) with n-butyl alcohol. Used as herbicide.

BUTYLENE-1 (Butene-1, Ethyl ethylene)—23, 156, 170, 229, 246, 277, 278, 321, 325, 327, 386, 393, 409

$CH_2CHCH_2CH_3$. Colorless gas. BP —20.7°F (—6.3°C), MP —202°F (—130°C). Made by petroleum cracking or recovery from refinery gases. Used to mfr. alkylate gasolines, butadiene, chemicals.

BUTYLENE-2 (Butene-2, Dimethyl ethylene)—23, 156, 170, 229, 246, 277, 278, 321, 327, 386, 393, 409

$CH_3CHCHCH_3$. Colorless gas. BP cis form 38.7°F (3.7°C), trans form 33.6°F (0.88°C); MP both forms —196.6°F (—127°C). Made by petroleum cracking or recovery from refinery gases. Used to mfr. alkylate gasolines, butadiene, chemicals.

1, 3-BUTYLENE GLYCOL—44, 191

$HOCH_2CH_2CH(OH)CH_3$. Colorless liq. BP 405.5° F (207.5°C), SG 1.01 (20/20°C), D 8.4 lb/gal. Made by aldol from acetaldehyde reduction. Used to mfr cellophane, textile fibers.

1,4-BUTYLENE GLYCOL (1,4-Butanediol, Tetramethylene glycol)—

$HOCH_2CH_2CH_2CH_2OH$. Colorless liquid. BP 446°F (230°C), FP 61°F (16°C), SG 1.020. Made from acetylene and formaldehyde by the Reppe process. Used as solvent, humectant; as intermediate in mfr. of plasticizers, plastics, pharmaceuticals.

BUTYROLACETONE

$OCH_2CH_2CH_2CO$. Colorless liquid. BP 464°F (240°C), FP—47°F (—44°C), SG 1.144. Made from acetylene by high-pressure synthesis. Used as chemical intermediate, solvent; in mfr. of paint removers.

BUTYRALDEHYDE (n-Butyl aldehyde—328, 340

$CH_3CH_2CH_2CHO$. Colorless liq. BP 168.3°F (75.7°C), FP —146.2°F (—99°C), SG 0.805 (20/20°C), D 6.7 lb/gal. Made by n-butanol dehydrogenation or crotonaldehyde partial reduction. Used to mfr. rubber goods, synthetic resins, butyric acid.

BUTYRIC ACID (Butanoic acid, Ethyl acetic acid)—45, 339, 340

$CH_3CH_2CH_2COOH$. Colorless liq. BP 326.7°F (163.7°C), MP —17.8°F (—7.9°C), SG 0.9587 (20/4°C). Made by butyraldehyde (from n-butanol oxidation) oxidation. Used to mfr. cellulose butyrate and cellulose acetate butyrate plastics, plasticizers, lacquers.

CARBAMATE FUNGICIDES (Metallo-alkyl and metallo-alkenyl dithiocarbamates)—110

E.g., $(CH_3)_2NCSSNa$ (sodium dimethyldithiocarbamate). Solids more-or-less soluble in water. Made by amines-carbon disulfide reaction in presence of an alkali. Used to kill or prevent growth of fungi and/or their spores.

CARBON BISULFIDE (Carbon disulfide)—29, 314, 366

CS_2. Colorless liq. BP 115.3°F (46.3°C), MP —163.5°F (—108.6°C), SG 1.263 (20/4°C), D 10.48 lb/gal. Made by natural gas (methane)-sulfur recation. Used to mfr. viscose rayon, carbon tetrachloride, varnishes, lacquers, paint and varnish removers, rubber products; as solvent for resins, rubber, waxes, sulfur, etc.

CARBON BLACKS—33, 34, 35, 36, 37, 38, 42, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 75, 76, 77, 78, 168, 169, 183, 231, 271, 281, 332, 344, 345, 346, 347, 348, 349, 350, 380

C. Black amorphous solid. BP 7,592°F (4200°C), MP 6332°F (3500+°C), SG 1.8-

2.1. Made by incomplete combustion or thermal decomposition of natural gas. Used in rubber compounding, inks, paints.

CARBON MONOXIDE

CO. Colorless gas. BP −310°F (−190°C), FP −326.2°F (−199°C), SG 0.967. Made by carbon dioxide-coke-oxygen reaction or incomplete combustion of natural gas with steam. Used as component of methanol synthesis gas, synthine (Fischer-Tropsch) reaction.

CARBON TETRACHLORIDE—11, 93, 97, 104, 317, 389

CCl_4. Colorless liq. BP 170.2°F (76.8°C), FP −9.4°F (−23.0°C), SG 1.595 (20/4°C), D 13.22 lb/gal. Made by carbon disulfide-chlorine reaction, or by methane chlorination and (as by-product) of higher hydrocarbons. Used as solvent, to mfr. Freon, chloroform, chlorinated organics, resins, lacquers.

CELLULOSE ACETATE (Acetyl cellulose)—381

$C_6H_8(COOCH_3)_2$ or C_4H_6O $(COOCH_3)_4$ or $C_6H_7O_2$-$(COOCH_3)_3$. White amorphous solid. MP 381-439°F (194-226°C), SG 1.329-1.365. Made by cellulose-acetic anhydride reaction followed by hydrolysis. Used to mfr. synthetic fibers, plastics, protective coatings.

CHLORAL—92

CHLORINATED BENZENE (Chlorobenzene, Chlorobenzol)

C_6H_5Cl. Colorless liq. BP 268.9°F (131.6°C), FP −49°F (−45°C), SG 1.105 (25/25°C), D 9.19 lb/gal. Made by benzene-chlorine reaction. Used as solvent; to mfr. phenol, aniline, picric acid, chloro- and nitrochlorobenzenes; as heat-transfer medium.

CHLORINATED PARAFFIN (Chlorocosane)—93

Light yellow-to-amber liq. SG 0.90-1.50. Made by meited paraffin-chlorine reaction. Used as dichloramine solvent; in textile mfr.

CHLORINATED SOLVENTS (Chlorohydrocarbon solvents)—373

Family of chlorinated hydrocarbons, including carbon tetrachloride, chloroform, ethylene dichloride, methyl chloride, methylene chloride, perchloroethylene, propylene dichloride, and trichloroethylene. Made, in general by refinery gas chlorination. Used as solvents and extractants for oils, waxes.

CHLORINATED WAXES (Chlorinated paraffins)—167

Products range from pale yellow, viscous liquids to brittle, resinous solids as chlorine content increases from about 28 to 70%. Made by passing chlorine through molten paraffin waxes. Used as plasticizers, extreme-pressure lubricant additives; to mfr. corrosion-resistant paints.

CHLOROBENZENE, see Chlorinated benzene—167

CHLOROFORM (Trichloromethane)—11, 96, 97, 104, 317

$CHCl_3$. Colorless liq. BP 142.2°F (61.2°C), FP −82.3°F (−63.5°C), SG 1.489 (20°C), D 12.4 lb/gal. Made by acetone-chlorinated lime ($CaOCl_2 \cdot H_2O$) reaction, or carbon tetrachloride reduction, or methane chlorination. Used as solvent; to mfr. aerosols, insecticides, vermicides, plastics; as fire extinguisher.

CHLOROHYDRINS—275

Generic name for polyhydroxy alcohols having one or more hydroxyl groups replaced by chlorine. E.g., $CH_2OHCHOHCH_2Cl$ (glyceryl alpha-chlorohydrin). Colorless liq. BP 416°F (213°C), FP −40°F (−40°C), SG 1.326 (18°C), D 11.012 lb/gal. Made by passing hydrogen chloride into glycerine containing acetic acid. Used as solvent for acetylcellulose, resins, cellulose acetate. Other chlorohydrins include ethylene chlorohydrin, $ClCH_2CH_2OH$; epichlorohydrin, CH_2OCHCH_2Cl; propylene chlorohydrin, $CH_3ClCHOHCH_2$; and dichlorohydrin, $CH_2ClCHOHCH_2Cl$, used as solvents.

CHLOROSULFONATED POLYETHYLENE—109

Partially chlorinated polyethylene into which sulfur-containing groups have been introduced; e.g., Hypalon S-2 synthetic rubber. Hypalon made by ethylene chlorination to 25-30% chlorine content and reacting it with sulfur dioxide to introduce sulfonyl chloride groups into polymer chain. Used as polymer or elastomer, when cross-linked by curing with metal oxides.

CHLOROTOLUENES (ortho, meta, and para isomers)—167

$CH_3C_6H_4Cl$. Colorless liq. BP 318-324°F (159-162°C), FP 43.7 to −54.4°F (6.5 to −48°C), SG 1.065-1.078. Made by toluidine diazotization. Used as solvents, chemical intermediates.

CORROSION INHIBITORS—249, 288, 291

CRESOLS (Cresylic acid, o-, m-, and p- cresol isomers)—23, 179, 185, 188, 242, 243, 278, 286, 289, 291, 310

$CH_3C_6H_4OH$. Yellowish liq. BP 383-401°F (195-205°C) MP 176°F (80°C), 1.044. Recovered from cracked naphthas and gas oils. Used to mfr. plastics, plasticizers, insecticides.

CUMENE (Isopropylbenzene)—163, 309, 379

$C_6H_5CH(CH_3)_2$. Colorless liq. BP 306.9°F (152.7°C), FP −140.8°F (−96°C), SG 0.8620, D 7.19 lb/gal. Made by benzene-propylene alkylation, or by benzene-isopropyl iodide interaction. Used as aviation gasoline blending agent; solvent; to mfr. lacquers, chemicals.

CYCLOHEXANE (Hexamethylene, Hexahydrobenzene)—170, 240, 278

C_6H_{12}. Colorless liq. BP 177.3°F (80.7°C), FP 43.3°F (6.3°C), SG 0.779. Made by benzene hydrogenation, or naphtha catalytic reforming, or recovery from natural-gasoline and petroleum fractions. Used as solvent for oils, waxes, cellulose ethers, crude rubber, resins; to mfr. adipic acid, paint and varnish removers.

CYCLOHEXANONE (Pimelic ketone, ketohexamethylene

$C_6H_{10}O$. Colorless to pale yellow liquid. BP 314.1°F (156.7°C), FP −53°F (−47°C), SG 0.9478. Made by oxidation of cyclohexanol. Used as chemical intermediate in mfr. of adipic acid, caprolactam, insecticides, herbicides, rubber accelerators, pharmaceuticals, perfumes, nonionic detergents, emulsion breakers, plastics, water-soluble resins, as solvent, leveling agent in dyeing.

CYMENE ALCOHOL (Carvacrol, Isopropyl-o-cresol, 2-Hydroxy-p-cymene)—163

$CH_3C_6H_3OHCH(CH_3)_2$. Colorless liq. BP 458.6°F (237°C), FP 32°F (0°C), SG 0.976 (20/4°C). Made by p-cymene sulfonation, followed by alkali fusion. Used to mfr. fungicides.

DDT—92, 95

DECYL ALCOHOL (n-Decanol)—120

$CH_3(CH_2)_8CH_2OH$. Colorless liq. BP 451.2°F (232.9°C), FP 42.8°F (6°C), SG 0.829. Made by glacial acetate acid—capric aldehyde (caprialdehyde) reaction. Used to mfr. surface-active agents, detergents, esters; as an antifoaming agent.

DEMULSIFYING AGENTS—

Organic solvents surface-active agents, or compounds antagonistic to the emulsifier in emulsions. E.g. hydrocarbon sulfonates. Used to render oil-water and water-oil emulsions unstable.

DIACETONE ALCOHOL (Diacetone, 4-hydroxy-4-methylpentanone-2)—340

$CH_3COCH_2C(CH_3)_2OH$. Colorless liquid. BP 336.4°F (169.1°C), FP −45°F (−42.8°C), SG 0.9406, D 7.8 lb/gal. Made by acetone condensation. Used as solvent, esp. in dopes, lacquers, and other coating compositions; in mfr. of wood preservatives, rayon, artificial leather, dyeing mixtures, celluloid cements, antifreeze mixtures, metal-cleaning compounds.

4,4'-DIAMINODIPHENYLSULFONE (Sulfonyldianiline)

$(C_6H_4NH_2)_2SO_2$. Colorless crystals. MP 347-9°F (175-176°C). Suggested use as curing agent for epoxy resins; used as medicine.

DIBUTYL BUTYLPHOSPHONATE

$C_4H_9P(O)(OC_4H_9)_2$. Colorless liquid. BP 261-3°F (127-8°C) at 2.5 mm, SG 0.948. Used as chemical intermediate, in mfr. of surface-active agents, anti-oxidants, metal deactivators, persticides.

DICHLOROBENZENE (o-, m-, and p- isomers)—55

$C_6H_4Cl_2$. Colorless liq. (o- and m- isomers) or white crystals (p- isomer). Properties: ortho BP 352.4-357°F (178-180.5°C), FP about 4°F (−19°C), SG 1.305, D 10.9 lb/gal; meta BP 341.6°F (172°C), FP −11.2°F (−24°C), SG 1.288; para BP 344.7°F (173.7°C), MP 127.4°F (53°C), SG 1.458. Made by monochlorobenzene chlorination. Used as chemical intermediate, solvent, insecticide; to mfr. surface coatings, resins.

DICHLORODIFLUOROMETHANE ("Freon-12")—105

CCl_2F_2. Colorless gas. BP −20.2°F (−29°C), FP −252.4°F (−158°C), SG 1.326 (20/4°C). Made by carbon terachloride-hydrogen fluoride reaction. Used as refrigerant, aerosol propellant.

DICHLOROETHYLENE (Acetylene dichloride, cis and trans isomers)

CHClCHCl. Colorless liq. BP cis isomer 136-140°F (58-60°C), trans isomer 117-120°F 47-49°C); SG cis 1.282, trans 1.257. Made by acetylene partial chlorination. Used as solvent for oils, resins, waxes, rubber shellac cellulose acetate; to mfr. plastics, lacquers, rubber, solvent mixtures.

DICHLOROETHYL ETHER—104, 215, 340

$ClCH_2CH_2OCH_2CH_2Cl$. Colorless liq. BP 353.3°F (178.5°C), FP −61.4°F (−51.9°C), SG 1.222, D 10.2 lb/gal. Made by ethyl ether chlorination. Used as solvent, to mfr. wetting agents, paints, varnishes, lacquers, finish removers; as chemical intermediate.

DICHLORO ISOPROPYL ETHER—104, 340

$ClCH_2CH_2CHOCHCH_2CH_2Cl$. Colorless liq. BP 369.3°F (187.4°C), SG 1.1135 (20/20°C), D 9.3 lb/gal. Made from propylene and hypochlorous acid via mfr. and dehydration of propylene chlorohydrin. Used as solvent for greases, waxes; as extractant, paint remover.

DICHLOROPHENOL (Isomeric dichlorophenols)—92

$Cl_2C_6H_3OH$. Commercial product consists 80-90% of 2, 4-dichlorophenol. Properties of 2, 4-isomer; BP 410°F (210°C), MP 113°F (45°C), SG 1.383 (60/25°C). Made by chlorination—phenol. Used to mfr. 2, 4-D (2, 4-dichlorophenoxyacetic acid).

2, 4-DICHLOROPHENOXYACETIC ACID, DIMETHYLAMINE SALT (2, 4-D dimethylamine salt)—40

$Cl_2C_6H_3OCH_2COO(CH_3)_2NH_2$. Colorless liq. Made by 2, 4-dichlorophenoxyacetic acid (2, 4-D)-dimethylamine reaction, the 2, 4-D being from 2, 4-dichlorophenol-monochloroacetic acid reaction. Used as weed killer.

DICYCLOPENTADIENE—120

$C_{10}H_{12}$. Solid. BP 338°F (170°CC, MP 92.5°F (33.6°C), SG 0.9766. Made by polymerization of cyclopentadiene (from cracked petroleum). Used as stable form for storage of cyclopentadiene (C_5H_6), which is raw material in resin mfr.

DIELDRIN (Hexachloro-epoxy-octahydro-dimethano-naphthalene)—274

White cryst, solid. MP 347-348.8°F (175-176°C). Used as insecticides

DIETHANOLAMINE—101

$NH(CH_2CH_2OH)_2$. Faintly colored liq. BP 516.4°F (269.1°C), FP 82.4°F (28°C), SG 1.092 (30/20°C), D 9.1 lb/gal. Made by ethylene oxide-ammonia reaction. Used as softening and moistening agent, acid gas solvent (Girdler process), chemical intermediate.

2, 5-DIETHOXYANILINE

$NH_2C_6H_3(OC_2H_5)_2$. White crystals. MP 180.5-185°F (82.5-85°C). Used as chemical intermediate, esp. for dyes for black-line and brown-line papers; in mfr. pharmaceuticals, insecticides.

DIETHYLBENZENE (o-, m-, and p- isomers)—101

$C_6H_4(C_2H_5)_2$. Colorless liq. BP o-, 362.1°F (183.48°C); m-, 357.9°F (181.13°C); p-, 362.8°F (183.78°C); FP o-, −23.5°F (−31.4°C); m-, −119.1°F (−83.92°C); p-, −45.8°F (−43.2°C); SG o-, 0.8805; m-, 0.8641; p-, 0.8619. By-product from ethybenzene production (by ethylene-benzene condensation. Used as solvent, chemical intermediate.

DIETHYL ETHYPHOSPHONATE

$C_2H_5P(O)(OC_2H_5)_2$. Colorless liquid. BP 180-2°F

(82-83°C) at 11 mm. SG 1.025. Used in mfr. of synthetic lubricants; as plasticizers, lube-oil additives.

DIETHYLENE GLYCOL—8, 104, 172, 215, 339, 340, 372, 373, 389

$CH_2OHCH_2OCH_2CH_2OH$. Colorless liq. BP 473.°F (245°C), FP 17.6°F (−8°C), SG 1.1184, D 9.35 lb/gal. Made by ethylene oxide-water hydration, or direct ethylene oxide-ethylene glycol reaction. Used as solvent, antifreeze, natural-gas dehydrant; to mfr. plastics.

DIETHYLENE GLYCOL DIMETHYL ETHER

$CH_3(OCH_2CH_2)_2OCH_3$. Colorless liquid. BP 324°F (162°C), FP −90°F (−68°C), SG 0.9451. Made by reaction of alcohol with ethylene oxide. Used as a solvent.

DIETHYLENE TRIAMINE—104, 338

$NH_2CH_2CH_2NHCH_2CH_2NH_2$. Colorless liq. BP 404.8°F (207.1°C). By-product of ethylene diamine mfr. Used as lubricant additive.

DIGLYCOLIC ACID

$O(CH_2COOH)_2$. White crystalline solid. MP 298°F (148°C). Used in mfr. of resins and plasticizers; as chemical intermediate.

2, 5-DIMETHOXYANILINE

$NH_2C_6H_3(OCH_3)_2$. Near-white crystals. MP 174-6°F (79-81°C). Used as chemical intermediate, esp. for light-sensitive diazo dyes; in mfr. of pharmaceuticals and insecticides.

2, 2-DIMETHOXYPROPANE

$H_3CC(CH_3O)_2CH_3$. Liquid. BP 169-180°F (76-82°C), FP −53°F (−47°C), SG 0.849. Used as dehydrating agent, solvent.

DIMETHYL FORMAMIDE—110

$HCON(CH_3)_2$. Colorless liq. BP 307°F (152.8 °C), SG 0.953-0.954. Made by dimethylamine acylation (with formic acid). Used as synthetic resins and acetylene solvent; potential use as solvent for polyacrylonitride.

DIMETHYL HEXANEDIOL

$(CH_3)_2COH(CH_2)_4COH(CH_3)_2$. White crystals. BP 417-9°F (214-215°C); MP 191.3-192.2°F (88.5-89°C); SG 0.898. Used as chemical intermediate, in mfr. of allethrin insecticide, alkylated phenol antioxidants.

DIMETHYL HEXYNEDIOL

$(CH_3)_2COHCCCOH(CH_3)_2$. White crystals. BP 401-3°F (205-206°C), MP 201-3°F (94-95°C), SG 0.949. Used as foam suppressant, coupling agent in plastics; in froth flotation, mfr. of plastics and flexographic inks; chemical intermediate.

DIETHYL HEXYNOL (3, 5-dimethyl-1-hexyne-3-ol)

$CHCCOH(CH_3)CH_2CH(CH_3)_2$. Colorless liquid. BP 302-4°F (150-151°C), sets to a glass below −90°F (−68°C), SG 0.8545. Used as solvent, corrosion inhibitor, surface-active agent, chemical intermediate.

DIMETHYL OCTANEDIOL

$C_6H_5(CH_3)COH(CH_2)_2COH(CH_3)C_6H_5$. White waxy solid. BP 466-8°F (241-242°C), MP 111°F (44°C), SG 0.919. Used as nonfoaming surface-active agent; uses needing temperature-stable glycol; chemical intermediate.

DIMETHYL OCTYNEDIOL

$C_6H_5(CH_3)COHCCCOH(CH_3)C_6H_5$. White crystals. BP 432°F (222°C), MP 131-3°F (55-56°C), SG 0.923. Used as surface-active agent; in mfr. plastics; chemical intermediate.

DIMETHYL SULFATE (Methyl sulfate)

$(CH_3)_2SO_4$. Colorless liquid. BP 370°F (188°C), FP −16.2°F (−26.8°C), SG 1.3516. Made by reacting methyl alcohol with fuming sulfuric acid. Used in mfr. of synthetic drugs and dye intermediates; as methylating agent.

DIMETHYL SULFOXIDE (DMSO)

$(CH_3)_2SO$. Colorless liquid. BP 372°F (189°C), MP 65.2°F (18.45°C), SG 1.100. Made by reacting methanol with hydrogen sulfide, followed by oxidation of resulting dimethyl sulfide with air and nitrogen dioxide. Potential uses include as solvent, antifreeze, paint remover, in lube-oil refining.

DIMETHYL TEREPHTHALATE—19, 162

$C_6H_4(COOCH_3)_2$. White flakes. BP 550.4°F (288°C), MP 285.1°F (140.6°C), SG 1.07 (150/25°C). Made by terephthalic acid-methyl alcohol esterification. Used to mfr. synthetic fibers (Dacron, Terylene), polyester plastic films (Mylar), plasticizers; in oil-modified alkyd resins.

DIPROPYLENE GLYCOL—44, 104, 340

$(CH_3CHOHCH_2)_2O$. Colorless liq. BP 449.2°F (231.8°C), SG 1.0252, D 8.5 lb./gal. Made by propylene oxide hydration or by propylene oxide-propylene glycol reaction. Used as solvent for nitrocellulose, shellac, cellulose acetate; in mfr. lacquers, surface coatings; as plasticizer.

2,6-DI-TERT-BUTYL-4-METHYLPHENOL (Includes Shell's "Ionol")

$(C_4H_9)_2CH_3C_6H_2OH$. Colorless solid. BP 509°F (265°C), MP 155.3°F (68.5°C), SG 0.899. Made by alkylation of cresol. Used as antioxidant for petroleum products, rubbers, plastics, foodstuffs, drugs.

DI-TERT-BUTYL PEROXIDE (DTBP)

$(CH_3)_3COOC(CH_3)_3$. Water-white liquid. BP 232°F (111°C), SG 0.794. Used as resin polymerization catalyst.

DIVINYLBENZENE (Vinylstyrene, o-, m-, and p- isomers)—101, 176

$C_6H_4(CHCH_2)_2$. Colorless liq. Meta isomer: BP 391.1°F (199.5°C), FP —88.4°F (—66.9°C), SG 0.9289. Made by diethylbenzene (made from benzene and ethylene) dehydrogenation. Used to mfr. synthetic rubbers, drying oils, ion-exchange resins, plastics.

DODECYL BENZENE—5, 23, 393

DODECYL MERCAPTAN (Lauryl mercaptan)

$C_{12}H_{25}SH$. Colorless-to-yellow liq. BP 392-455°F (200-235°C), SG 0.85. Made by dodecene-hydrogen sulfide reaction; or treating dodecene with thioacetic acid, converting resulting ester by alcoholysis to dodecyl mercaptan. Used to mfr. synthetic rubber (polymerization controller), plastics, insecticides, fungicides.

DRY ICE AND LIQUID CARBON DIOXIDE—51, 195, 300, 304, 307

CO_2. White solid or colorless liq. BP —108.8°F (—78.2°C), FP —68.8°F (—56°C at 5 atm.), SG liq. 1.057, SG solid 1.56. From natural gas or petroleum hydrocarbon combustion. Used as chemical intermediate, as dehydrating agent, to produce inert atmospheres and vacuums.

DYNEL

Tradename for Union Carbide copolymer of CH_2CHCl (vinyl chloride) and CH_2CHCN (acrylonitrile). Light cream solid. Softens at 300-325°F, SG 1.30 (25°C). Used as textile fiber.

ENDRIN—274

Hexachloro - epoxy - octahydro - endo - endo - dimethanonaphthalene. An insecticide isomeric with dieldrin and generically similar to aldrin and dieldrin. Used as insecticide.

EPICHLOROHYDRIN (Chloropropylene oxide)—104

CH_2OCHCH_2Cl. Colorless liquid. BP 239.4°F (115.2°C), FP —72.6°F (—58.1°C), SG 1.179-1.184, D 9.78 lb/gal. Used in mfr. of epoxy resins; as solvent; in mfr. of lacquers, paints, varnishes, fumigants, surface-active agents, ion-exchange resins.

EPON RESINS—276, 407

Trade name of epoxy resins produced by Shell Chemical Corp. Made by epichlorohydrin-bisphenol A condensation. Used to mfr. surface coatings, chemical-resistant enamels.

ESTERS—43, 47, 338, 339, 340, 381

RCOOR¹ (R and R¹ are hydrocarbon radicals). Colorless liquids to colorless crystalline solids, depending on chain length. Made by alcohol-organic acid reaction. Used as solvents and plasticizers; to mfr. plastics, surface coatings.

ETHANOL (Ethyl alcohol)—20, 120, 200, 328, 336, 338, 339

CH_3CH_2OH. Colorless liq. 172.9°F (78.3°C), FP —169.6°F (—112°C), SG 0.7905, D 6.578 lb/gal. Made by direct catalytic hydration of ethylene; or via ethyl sulfate intermediate; or by carbon monoxide-hydrogen catalytic synthesis (methanol-synthesis by-product, also Fischer-Tropsch). Used as antifreeze; to mfr. acetaldehyde, ethyl acetate, ether, chloroform, iodoform, butadiene; as solvent and extraction medium.

ETHANOLAMINES (See Mono-, Di-, and Tri-) —8, 172, 215, 337, 340, 387, 389

ETHERS—120, 200, 338, 339, 340, 373

ROR¹ (R and R¹ are hydrocarbon radicals). Generally pleasant-smelling liquids with BP < corresponding alcohols, SG<1.00. Made by alcohol dehydration. Used as extractants and solvents.

ETHYL AMYL KETONE (Octanone-3)

$CH_3CH_2CO(CH_2)_4CH_3$. Colorless liquid. BP 313-324°F (156-162°C), SG 0.820-0.824. Used as solvent for lacquers, air-dry vinyl coatings; in dewaxing and deoiling; in mfr. rubber chemicals, insecticides, printing inks, blush retarders, perfumes.

ETHYLBENZENE—88, 101, 178, 193

$C_6H_5C_2H_5$. Colorless liq. BP 277.2°F (136.2°C), FP —139.0°F (—94.98°C), SG 0.867, D 7.21 lb/gal. Made by benzene-ethyl chloride reaction. Used as intermediate for styrene; as solvent and diluent.

ETHYL CELLULOSE (Cellulose ether)—104

White granular solid. SG 1.07-1.18. Properties vary depending on extent of replacement of hydroxy radicals. Made from alkali cellulose and ethyl chloride or ethyl sulfate, or from cellulose and ethyl alcohol in presence of dehydrating agents. Used to mfr. adhesives, lacquers, plastics.

ETHYL CHLORIDE—101, 104, 105, 123, 124, 200

CH_3CH_2Cl. Colorless gas. BP 54.1°F (12.27°C), MP —216.9°F (—138.3°C), SG 0.917 (6/6°C). Made by addition of hydrogen chloride to ethylene, or from ethyl alcohol-hydrogen chloride reaction. Used to mfr. tetraethyl lead, ethyl cellulose; as refrigerant; as solvent for phosphorus, sulfur, resins, oils, waxes.

ETHYLENE (ETHENE)—46, 48, 89, 100, 122, 156, 237, 262, 327, 386, 387, 389, 393, 401

CH_2CH_2. Colorless gas. BP —152.5°F (—102.5°C), MP —272.2°F (—169°C), SG 0.978. Made by petroleum cracking, or recovery from refinery gases, or passing ethyl alcohol over dehydration catalyst. Used as intermediate for ethanol, ethylene dibromide, ethylene dichloride, styrene; to mfr. polyethylene plastics.

ETHYLENE AMINES (See Ethylene diamine, Piperozine, Diethylene triamine, Triethylene tetramine, Tetraethylene pentamine).

ETHYLENE DIAMINE—101, 104, 215

$NH_2CH_2CH_2NH_2$. Colorless liq. BP 242.6°F (117°C), SG 0.892. Made by corresponding dinitrile reduction, or by ammonia-acetylene (or ethylene) reaction. Used as solvent for oils, waxes; to mfr. sequestering agents.

ETHYLENE DIBROMIDE (Ethylene bromide, Dibromoethane)—101, 125

CH_2BrCH_2Br. Colorless liq. BP 268°F (131°C), FP 48.4°F (9.1°C), SG 2.17-2.18, D 18.1 lb/gal. Made by ethylene-bromine reaction. Used in tetraethyl lead antiknock fluids; solvent for oils, waxes, plastics; to mfr. waterproofing compounds, celluloid, organic chemicals.

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

ETHYLENE DICHLORIDE (Dichloroethane, Ethylene chloride)—94, 101, 104, 123, 124, 172, 193, 215, 338, 373

CH_2ClCH_2Cl. Colorless liq. BP 182.3°F (83.5°C), FP —31.9°F (—35.5°C), SG 1.2554 (20/40°C), D 10.4 lb/gal. Made by ethylene-chlorine reaction. Used in tetraethyl lead antiknock fluids; solvent for oils, waxes, rubber, plastics; to mfr. lacquers, paint removers, wetting agents, ethylene diamine.

ETHYLENE GLYCOL—8, 39, 104, 134, 172, 215, 335, 336, 337, 338, 339, 340, 372, 373, 387, 389

CH_2OHCH_2OH. Colorless liq. BP 387°F (197.2°C), FP 1.4°F (—17°C), SG 1.1155, D 9.31 lb/gal. Made by oxidation of ethylene to ethylene oxide, followed by hydration of the oxide; or by mfr. of ethylene chlorohydrin (from ethylene and chlorine), followed by hydrolysis. Used as antifreeze, solvent, chemical intermediate; to mfr. brake fluids, lacquers, resins, synthetic fibers.

ETHYLENE GLYCOL DIACETATE—44

$(CH_3OOCCH_3)_2$. Colorless liq. BP 359.6°F (182°C), SG 1.11. Made by ethylene oxide-acetic acid (or acetic anhydride) reaction. Used as solvent for resins, cellulose derivatives.

ETHYLENE GLYCOL MONO-OLEATE—40

$C_{17}H_{33}COOCH_2CH_2OH$. Colorless liq. BP 374-392°F (190-200 at reduced pressure), FP 33.8°F (1°C). Made by ethylene glycol-oleic acid reaction. Used as surface-active, emulsifying, stabilizing, dispersing, wetting, foaming, and suspending agents.

ETHYLENE OXIDE—8, 39, 101, 104, 134, 172, 215, 335, 336, 337, 338, 339, 372, 387, 389

CH_2CH_2O. Colorless gas. BP 55-57°F (13-14°C) FP —167.8°F (—111°C), SG 0.882, D 7.2 lb/gal (20°C). Made by oxidation of ethylene, or by ethylene chlorohydrin—alkali reaction. Used as intermediate for ethylene glycol.

ETHYL ETHER (Ether, diethyl ether, Sulfuric ether)—120

$(CH_3CH_2)_2O$. Colorless gas. BP 94.1°F (34.5°C), FP —177.2°F (—116.2°C), SG 0.7147, D 6 lb/gal (20°C). Made by sulfuric acid dehydration of ethyl alcohol, or by-product in mfr. of ethyl alcohol from ethylene. Used as chemical intermediate, solvent, refrigerant, alcohol denaturant.

2-ETHYLHEXANOL (2-Ethylhexyl alcohol, Octyl alcohol—328, 373

$CH_3(CH_2)_3CHC_2H_5CH_2OH$. Colorless liq. BP 362.3°F (183.5°C), SG 0.83, D 6.9 lb/gal. Made by 1-ethylhexaldehyde (made from n-butraldehyde) reduction. Used as defoaming and wetting agent; chemical intermediate; to mfr. plasticizers and detergents.

2-ETHYLHEXYL OCTYLPHENYL PHOSPHITE

$(C_8H_{17}O)(C_8H_{17}C_6H_4O)P$. Colorless to light yellow liquid. BP above 320°F (160°C) at 0.3 mm, flash point 385-390°F. SG 0.935-0.950. Used as plasticizer, color inhibitor, antioxidant, flame retardant, lube-oil additive.

ETHYL MERCAPTAN (Ethyl sulfhydrate)

CH_3CH_2SH. Colorless liq. BP 97.9°F (36.2°C), FP —185.8°F (—121°C), SG 0.839. Made by calcium ethyl sulfate-hydrogen sulfide (in alkali solution) reaction. Used as gas odorant.

1-ETHYNYL CYCLOHEXANOL

$HC_2C_6H_{10}OH$. Colorless solid. BP 356°F (180°C), MP 86-8°F (30-31°C), SG 0.967. Used as stabilizer of chlorinated organics, solvent, corrosion inhibitor, chemical intermediate.

EXPLOSIVES—355

Substances capable of undergoing very rapid, self-propagating decomposition. E.g., trinitrotoluene, $CH_3C_6H_2(NO_2)_3$; yellow solid, MP 177.6°F (80.9°C), SG 1.654; made by nitration of toluene with mixed acid. Used as high explosive for military and industry. Other petroleum-derived explosives include ammonium nitrate, nitroglycerin, ethylenedinitramine, and glycol dinitrate (used to mfr. dynamite).

FORMALDEHYDE—7, 30, 31, 44, 161, 250, 255, 258, 259, 260, 303, 364, 376, 405

HCHO (usually in H_2O). Colorless gas (or liq. in aqueous sol.). Properties gas; BP —2.2°F (—19.°C), MP —180.4°F (—118°C), SG 0.815 (—20°C). Properties 37% sol.; BP (101°C), SG 1.112. Made by natural gas oxidation, or by methanol-air reaction. Used to mfr. formic acid, urea, hexamethylene-tetramine, acetaldehyde, paraformaldehyde, pentaerythritol, plastics, synthetic fibers, adhesives.

FORMAMIDE (Methanamide)

$HCONH_2$. Colorless liquid. BP 392-414°F (200-212°C), FP 36.5°F (2.5°C), SG 1.146. Made by reacting ammonia with ethyl formate (derivable from ethanol). Used as solvent, softener for papers and glues, in mfr. of formic acid and pharmaceuticals.

GAS ODORANTS—201, 217, 310

Gaseous or liquid organic sulfur compounds. Often, but not always, mercaptans such as ethyl mercaptan (tradename "Captan") or amyl mercaptan (tradename "Pentalarm"). "Calodorant" is a special, sulfurous hydrocarbon fraction of petroleum. Used to odorize natural gas so that leaks can be detected.

GLYCERINE (Glycerol)—104, 275, 276

$CH_2OHCHOHCH_2OH$. Colorless-to-yellow liq. BP 554°F (290°C), FP 64.2°F (17.9°C), SG 1.260, D 10.5 lb/gal. Made from propylene via prod. of allyl alcohol, its chlorination and hydrolysis with alkali solution. Used to mfr. alkyd resins, synthetic fibers; as solvent, antifreeze, plasticizer.

GLYCOLS (See Ethylene glycol, Diethylene glycol, Triethylene glycol, Propylene glycol, butylene glycol)—100, 338, 339, 340

GLYCOL ETHERS—387

$ROCH_2(CH_2OH)_n$ (R is a hydrocarbon radical). Made by treating ethylene oxide with excess alcohol (e.g., ethanol), or by glycols-alkyl sulfates reaction. Used as solvents and chemical intermediates.

HEXACHLOROBENZENE—92

C_6Cl_6. White needles. BP 618.8°F (326°C), MP 444.2°F (229°C). Made by hexyl iodide-iodine chloride reaction. Used as chemical intermediate.

HEXACHLOROBUTADIENE

$Cl_2CCClCClCCl_2$. Colorless liq. BP 410-428°F (210-220°C), FP —2 to —8°F (—19 to —22°C), SG 1.675 (15.5°C), D 13.97 lb/gal (15.5°C). Made by butadiene chlorination. Used as solvent, noninflammable heat-transfer liquid, transformer and hydraulic fluid, extractant (for C_4 and higher hydrocarbons).

HEXACHLOROCYCLOPENTADIENE (tradename "C-56")—167

C_5Cl_6. Yellow-to-amber liq. BP 456.8°F (236°C), FP 28.4°F (—2°C), SG 1.715 (15°C), D 14.3 lb/gal (15.5°C). Made by cyclopentadiene chlorination. Used as chemical intermediate.

HEXACHLOROETHANE (Carbon trichloride, Perchloroethane)—95

CCl_3CCl_3. Colorless cryst. solid. MP 365°F (185°C); sublimes at 185°C; SG 2.091. Made by higher hydrocarbon chlorinolysis (with carbon tetrachloride by-product); or by trichloroethane or tetrachloroethylene chlorination. Used as chemical intermediate, solvent, camphor substitute in mfr. of celluloid, rubber accelerator.

HEXAMETHYLENE DIAMINE—114, 303, 390

$NH_2(CH_2)_6NH_2$. Colorless solid. BP 384.8°F (196°C), MP 102-104°F (39-40°C). Made by adiponitrile-hydrogen-ammonia reaction. Used to mfr. nylon.

1,2,6-HEXANETRIOL

$CH_2OHCHOHCH_2CH_2CH_2OH$. Colorless liquid. BP 352°F (178°C) at 5 mm. FP (sets to glass) —4°F (—20°C), SG 1.1063. Used as chemical intermediate in mfr. of urethane foams, as softener, moistening agent, solvent.

HEXYLENE GLYCOL

$C_6H_{14}O_2$. Colorless liquid. BP 378-392°F (192-200°C), SG 0.922-0.925, D 7.7 lb/gal. Used as coupling agent for hydraulic brake fluids, moistening and softening agent, arinding and extrusion aid; in mfr. soluble oils, cleaning compounds, lubricating oils, textiles, paper.

HYDRAZINE—216

H_2NNH_2. Colorless liq. BP 234.5°F (113.5°C), FP 35.6°F (2°C), SG 1.011. Made by hydrazine hydrate (from oxidation of ammonia or urea by hypochlorite) dehydration. Used as rocket fuel, solvent, reducing agent, chemical intermediate.

HYDROCYANIC ACID, See Hydrogen cyanide

HYDROGEN—117, 205, 293, 321, 386, 409

H_2. Colorless gas. BP —423°F (—252.8°C), FP —434.4°F (—259.1°C), SG 0.06948 (air=1). Made from natural-gas by reaction with steam or thermal decomposition, or by-product from naphtha reforming. Used to mfr. ammonia, methanol; in unsaturated hydrocarbons hydrogenation.

HYDROGEN CHLORIDE (Hydrochloric acid)—11, 93, 94, 317, 389

HCl. Colorless gas. BP —117.6°F (—83.1°C), FP —167.8°F (—111°C), D 1.6392 gms/liter (0°C). Made by hydrogen-chlorine reaction, or by-products from hydrocarbon chlorination. Used to mfr. vinyl chloride, alkyl chlorides, paints.

HYDROGEN CYANIDE (Hydrocyanic acid, Prussic acid)—13, 108, 193, 263

HCN. Colorless liq. BP 78.1°F (25.6°C), FP 8.1°F (—13.3°C), SG 0.6970. Made by methane-ammonia-air reaction or treating cyanide salts with sulfuric acid. Used as fumigant; to mfr. acetone cyanhydrin, ethylene cyanhydrin, acrylic resins.

HYDROGEN PEROXIDE—275

H_2O_2. Colorless liq. BP 316.4°F (158°C, FP 28.4°F (—2°C), SG 1.46. Made by oxidation of sulfuric acid or sulfates to persulfuric acid or persalts, followed by hydrolysis to peroxide. Used as rocket fuel, oxidizing agent, polymerization catalyst; to mfr. synthetic rubber.

HYDROGEN SULFIDE—240, 262

H_2S. Colorless gas. BP —76.4°F (—60.2°C), FP —118.8°F (—83.8°C), SG 1.1895. Recovered from sour natural gas and petroleum, or formed during refining of sulfur-containing oils. Used as chemical intermediate, purification agent, analytical reagent.

INSECTICIDES, synthetic organic (see also specific materials)—359

E.g., $(ClC_6H_4)_2CHCCl_3$ (DDT), MP 227.3-228.2°F (108.5-109°C), SG 1.556. From chlorobenzene-chloral condensation. Halogenated insecticides include methoxychlor, $CH_3O(C_6H_4)CHCCl_3(C_6H_4)OCH_3$, benzene hexachloride, chlordane, (octachloromethano-tetrahydroindan), aldrin and dieldrin. Other synthetic insecticides include organic rhosphorus compounds (e.g., tetraethyl pyrophosphate) organic nitrogen compounds (e.g., dinitro-o-cresol), organic sulfur compounds (e.g., aliphatic thiocyanates).

"IONOL" (Tradename for 2,6-di-tert-butyl-4-methylphenol marketed by Shell Chemical Corp.)

ISOBUTANOL (Isobutyl alcohol, Isopropyl carbinol, 2-methylpropanol-1)—20, 44, 328, 338, 340

$(CH_3)_2CHCH_2OH$. Colorless liq. BP 226.2°F (107.9°C), FP —162.4°F (—108°C), SG 0.798 (25/4°C), D 6.65 lb/gal. By-product of synthetic methanol process, or from oxidation of butane. Used as solvent; in hydraulic-brake fluids; to mfr. isobutyl acetate, isobutyl aldehyde, paint removers.

ISOBUTYL ACETATE—44

$(CH_3)_2CHCH_2OOCCH_3$. Colorless liq. BP 244.4°F (118°C), FP —146°F (—98.9°C, SG 0.871 (20/4°C), D 7.26 lb/gal. Made by isobutyl alcohol-acetic acid reaction. Used as nitrocellulose solvent; to mfr. protective coatings.

ISOBUTYLENE (Isobutene, 2-methylpropene)—23, 120, 122, 401

$(CH_3)_2CCH_2$. Colorless gas. BP 19.6°F (—6.9°C), MP —218.2°F (—139°C). Recovered from refinery gases. Used to mfr. alkylate and polymer gasolines, butyl rubber; intermediate for alkyl halides.

ISOBUTYRALDEHYDE (Isobutyl aldehyde)—328

$(CH_3)_2CHCHO$. Colorless liq. BP 145-147°F (63-64°C). SG 0.797. Made by isobutanol oxidation. Used as chemical intermediate.

ISOBUTYRONITRILE (Isopropyl cyanide, 2-Methypropanenitrile)—328

$(CH_3)_2CHCN$. Colorless liq. BP 224.6°F (107°C). Made by isopropanol-hydrogen cyanide reaction; by isobutylene-ammonia reaction; or dehydrogenation or oxidation of isobutylamine. Used as chemical intermediate.

ISOCYANATES—191

RNCO (R is hydrocarbon radical). E.g., $C_{18}H_{37}NCO$, octadecyl isocyanate. BP 302-356°F (150-180°C), FP 59-64.4°F (15-18°C). SG 0.86. Isocyanates made by phosgene ($COCl_2$)-amine salt reaction. Used to mfr. plastics, adhesives, foamed resins, synthetic fibers and rubber (Vulcollan).

ISOOCTYL ALCOHO—120, 156

$C_7H_{15}CH_2OH$. Colorless liq. (isomeric mixt.). Properties roughly similar to 2-ethylhexanol (which see). Made from C_7 hydrocarbons by Oxo process (hydrogen-carbon monoxide reaction). Used as solvent, emulsifier, anti-foaming agent; to mfr. plasticizers, nonionic detergents, synthetic drying oils, hydraulic fluids, lubricants.

ISOPHTHALIC ACID (Benzene-meta-dicarboxylic acid)—19, 310

$C_6H_4(COOH)_2$. White cryst. solid. MP 662°F (350°C). Made by meta-xylene oxidation. Use (potential) to mfr. alkyd and polyester resins, plasticizers, surface coatings.

ISOPRENE—120

$CH_2C(CH_3)CHCH_2$. Colorless liq. BP 93.4°F (34.08°C), FP −230.8°F (−146°C), SG 0.6808 (20/4°C). Made by isopentene or isopentane dehydrogenation, or high-temperature thermal cracking of petroleum. Used to mfr. butyl and other synthetic rubbers, plastics, chemicals.

ISOPROPANOL (Isopropyl alcohol, Dimethyl carbinol)—20, 120, 122, 336, 338, 339, 340, 375, 407

$(CH_3)_2CHOH$. Colorless liq. BP 180.3°F (82.4°C), FP −126.2°F (−97.9°C), SG 0.7863, D 6.55 lb/gal. Made by propylene-sulfuric acid reaction, followed by hydrolysis of the sulfate. Used to mfr. lacquers, acetone; as antifreeze, solvent, extractant, dehydrating agent.

ISOPROPANOL AMINES (Mixed mono-, di-, and tri-)—101, 340

E.g., $CH_3CHOHCH_2NH_2$. Colorless liq. BP 113°F (45°C) at 5 mm Hg. SG 0.981. Made by propylene oxide-ammonia reaction. Used as chemical intermediates; in soap mfr.

ISOPROPENYL ACETYLENE

$(CH_3)_2CHCCH$. Liquid. BP 91.8°F (33.2°C); MP −171°F (−113°C); SG 0.695. Used as chemical intermediate, esp. for pharmaceuticals and aromatics; in vinyl copolymers; as specialty low-ignition-energy fuel.

ISOPROPYL ACETATE—122, 338, 340

$CH_3COOCH(CH_3)_2$. Colorless liq. BP 192.9°F (89.4°C), FP −100.1°F (−73.4°C), SG 0.877 (15.5°C), D 7.17 lb/gal. Made by isopropyl alcohol-acetic acid reaction. Used as solvent; to mfr. surface coatings, plastics, lacquers.

ISOPROPYL BENZENE, see Cumene

ISOPROPYL CHLORIDE—101

$(CH_3)_2CHCl$. Colorless liq. 97.7°F (36.5°C), SG 0.860. Made by isopropanol-hydrogen chloride reaction. Used as chemical intermediate.

ISOPROPYL -2,4-DICHLOROPHENOXYACETATE—40

Weedkiller made by 2,4-D (2,4-dichlorophenoxyacetic acid)-isopropanol reaction. Used as herbicide.

ISOPROPYL ETHER (Diisopropyl ether—122, 340

$(CH_3)_2CHOCH(CH_3)_2$. Colorless liq., BP 153.5°F (67.5°C), MP −126.4°F (−88°C), SG 0.723 (15.5/4°C), D 6.05 lb/gal (60°F). Made by isopropyl sulfate (from propylene sulfonation)-isopropyl alcohol reaction. Used as solvent and blending agent in high-octane gasolines.

KETONES (see also specific ones)—338, 339, 340, 381

RCOR′ (R and R′ are hydrocarbon radicals). E.g., see methyl ethyl ketone. Aliphatic ketones made by secondary alcohol oxidation or dehydrogenation, or by acetylene hydration. Aromatic ketones made by organic acid halide-aromatic hydrocarbon condensation. Used as solvents, to mfr. plastics.

LATEX—104, 128, 137, 148, 389

Emulsion containing about 60% water, 35% natural or synthetic rubber, and 5% emulsifying agents and stabilizers (natural or added). Made by emulsifying natural or synthetic rubber in water. Used to mfr. rubber products, latex paints.

LINDANE (Gamma-benzene hexachloride)

$C_6H_6Cl_6$. White solid. MP 233.6°F (112°C). Made by photochemical chlorination of benzene. Used as insecticide.

MALEIC ANHYDRIDE—257

$(CHCO)_2O$. White needles or flakes. BP 391.5°F (199.7°C), MP 127.4°F (53°C), SG 0.934 (20/4°C). Made by benzene oxidation. Used as chemical intermediate; to mfr. plastics.

MESITYL OXIDE (Isopropylidineacetone, Methyl isobutenylketone, 4-methyl-3-penten-2-one)—339

$(CH_3)_2CCHCOCH_3$. Colorless liquid. BP 266-8°F (130-131°C), FP −51.5°F (−46.4°C), SG 0.8569, D 7.1 lb/gal. Made by dehydration of acetone or diacetone alcohol. Used as solvent for cellulosics, synthetic rubbers, gums, resins, lacquers, roll-coating inks; in mfr. paint and varnish removers, insect repellent; for ode flotation.

METALLIC NAPHTHENATES—43, 209, 210, 211, 368, 369

Metallic salts of naphthenic acids. Made by lead salt-aqueous sodium naphthenate solution (obtained by caustic scrubbing of kerosene and petroleum gas-oil fractions) reaction. Used to mfr. greases, paint driers, cutting oils, plastics.

METHANOL (Methyl alcohol, wood alcohol)—7, 20, 44, 45, 71, 111, 161, 193, 304, 338, 340

CH_3OH. Colorless liq. BP 148.5°F (64.7°C), FP −144°F (−97.9°C), SG 0.792 (20/4°C), D 6.59 lb/gal. Synthesized from carbon monoxide and hydrogen, or from partial oxidation of natural gas. Used as antifreeze, ethyl alcohol denaturant, solvent; to mfr. formaldehyde, dimethylamine, dimethylaniline.

METHIONINE—109

$CH_3SCH_2CH_2CH(NH_2)COOH$. Solid. MP 538-541°F (281-283°C). Made from acrolein and methanol mercaptan or monothioethylene glycol. Used as growth accessory; in pharmaceuticals.

3-METHOXY BUTYL ALCOHOL (3-Methoxybutanol)

$CH_3CH(OCH_3)CH_2CH_2OH$. Colorless liquid. BP 322°F (161.1°C), FP −121°F (−85°C), SG 0.9229, D 7.68 lb/gal. Made from 1,3-butylene glycol by etherification. Used as solvent for cellulosics, resins, waxes; in mfr. of dyes, inks, pharmaceuticals, insecticides, lubricants and brake fluids.

METHYLAL (Dimethoxymethane, Formal)—44

$CH_3OCH_2OCH_3$. Colorless liq. BP 108.4°F (42.3°C), FP −156.6°F (−104.8°C), SG 0.86 (20/4°C). Made by formaldehyde polymerization. Used as solvent, chemical intermediate, special fuel; to mfr. protective coatings.

METHYL ACETYLENE—104

CH_3CCH. Gas. BP −9.5°F (−23.1°C); MP −150.7°F (−101.5°C); SG 0.678 (−27/4°C). Used as chemical intermediate, esp. for pharmaceuticals and aromatics, as specialty low-ignition-energy fuel.

METHYL AMINE (Monomethylamine)—101, 340

CH_3NH_2. Colorless gas. BP 22-21°F (−5.5 to −6.0°C), MP −139.9°F (−95.5°C), SG 0.699 18.8/5°C). Made by methanol-ammonia reaction. Used as solvent; to mfr. chemicals.

METHYL BUTYL KETONE (Propylacetone)—20

$CH_3COC_4H_9$. Colorless liq. Isomeric mixt. ranging in BP from 223-261°F (106-127°C); SG

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

n-form, 0.830. Made by dehydrogenation or oxidation of C_5 alcohols, or acetic acid-butyl carbinol reaction. Used as solvent, chemical intermediate.

METHYL BUTYNOL—1

$HCCCOH(CH_3)_2$. Colorless liquid. BP 219-221°F (104-105°C), MP 36.7°F (2.6°C), SG 0.8672. Used as solvent, corrosion inhibitor, stabilizer of chlorinated organics, intermediate for isoprenoid materials (synthetic rubbers).

METHYL CELLULOSE—101

White solid. Made by alkali cellulose-methyl chloride (or methyl alcohol) reaction and dehydrating agents. Used as adhesive; dispersing, thickening, emulsifying, and sizing agent.

METHYL CHLORIDE (Chloromethane)—11, 96, 97, 104

CH_3Cl. Colorless gas. BP −10.7°F (−23.7°C), MP −143.7°F (−97.6°C), SG 0.92, D 7.68 lb/gal. Made by methanol-hydrochloric acid reaction in presence of sulfuric acid. Used as refrigerant, methylating agent, extractant, solvent.

METHYL CHLOROFORM (1,1,1-Trichloroethane)—104

CH_3CCl_3. Colorless liq. BP 167°F (75°C), SG 1.325. Made by asymmetric dichloroethylene-hydrogen chloride reaction. Used in medicine.

METHYL ETHYL KETONE—20, 45, 122, 407

$CH_3COCH_2CH_3$. Colorless liq. BP 175.3°F (79.6°C), FP −123.3°F (−86.4°C), SG 0.805 (20/4°C), FP 6.71 lb/gal. Made by sec-butyl alcohol dehydrogenation, or modified Fischer-Tropsch process from carbon monoxide and hydrogen. Used as solvent, chemical intermediate; to mfr. lacquers, celluloid, varnish removers.

METHYL ETHYL PYRIDINE (2-Methyl-5-ethylpyridine)—339

$CH_3C_5H_3NCH_2CH_3$. Colorless liquid. BP 352.9°F (178.3°C), FP −94.5°F (−70.3°C), SG 0.921. Made by catalytic reaction of paraldehyde with ammonia. Used as solvent, acid acceptor, chemical intermediate; in mfr. of vitamins, pharmaceuticals, vinyl pyridine monomers, corrosion inhibitors.

METHYL FORMATE

$HCOOCH_3$. Colorless liquid. BP 89.2°F (31.8°C), FP −147.6°F (−99.8°C), SG 0.95-0.98. Made by reacting methanol with sodium formate and hydrochloric acid. Used as solvent for cellulosics, acrylic resins, polyvinyl acetate; in mfr. of sulfa drugs, fumigants.

METHYL ISOBUTYL CARBINOL (Methylamyl alcohol, 4-methylpentanol-2)

$(CH_3)_2CHCH_2CHOHCH_3$. Colorless liquid. BP 269.2°F (131.8°C), SG 0.8079, D 6.72 lb/gal. Used as lacquer solvent, in hydraulic brake fluids, ore flotation, lubricating-oil additives.

METHYL ISOBUTYL KETONE—336, 338, 339, 340

$(CH_3)_2CHCH_2COCH_3$. Colorless liquid. BP 240.4°F (115.8°C), FP −112.7°F (−80.4°C), SG 0.8042, D 6.68 lb/gal. Used as solvent for cellulose esters, vinyl plastics, in mfr. of lacquers.

METHYL ISOPROPENYL KETONE

$CH_2COC(CH_3)CH_2$. Liquid. BP 208°F (98°C), FP −51.7°F (−46.5°C), SG 0.854. Potential uses as chemical intermediate and in mfr. of plastics.

METHYL MERCAPTAN (Methanethiol)—16, 21

CH_3SH. Colorless gas. BP 45.7°F (7.6°C), FP −189.4°F (−123.1°C). Made by methanol-hydrogen sulfide reaction, or recovery from petroleum naphthas. Used in synthesis of methionine; potentially to mfr. Plastics, jet-fuel additives, fungicides.

METHYL PENTYNOL (Methylparafynol)

$HCCCOH(CH_3)CH_2CH_3$. Colorless liquid. BP 250-2°F (121-122°C), MP −23°F (−30.6°C), SG 0.8721. Used as solvent, corrosion inhibitor,

stabilizer of chlorinated organics; in mfr. protective coatings, pharmaceuticals; in medicine as hypnotic.

METHYL PROPYL KETONE (Ethyl acetone) —20

$CH_3COCH_2CH_2CH_3$. Colorless liq. BP 215.1°F (101.7°C), SG 0.809. Made by amyl alcohol dehydrogenation. Used as solvent, chemical intermediate.

METHYL VINYL PYRIDINE (2-Methyl-5 vinylpyridine)—236

$CH_3C_5H_3NCHCH_2$. Liquid. BP 354.2°F (179°C), MP (−12°C), SG 0.964 (20/4°C). Made by 2-methyl-5-ethyl pyridine dehydrogenation (in turn made by paraldehyde-aqueous ammonia reaction). Used as copolymer with butadiene and styrene to mfr. synthetic rubbers; with acrylonitrile to improve synthetic fiber dyeability; to mfr. ion-exchange resins.

METHYL STYRENE—163, 375

$C_6H_5C(CH_3)CH_2$. Colorless liq. BP 329.7°F (165.38°C), FP −9.8°F (−23.21°C), SG 0.9062 (25°C). Made from benzene and propylene via alkylation to cumene, followed by dehydrogenation. Used as monomer to make plastics, synthetic rubbers, and other high polymers.

METHYLENE CHLORIDE (Methylene dichloride) —11, 96, 97, 104, 317

$CHCl_2$. Colorless liq. BP 107.6°F (42°C), MP −142.6°F (−97°C), SG 1.335 (15/4°C), D 11.07 lb/gal. Made by methyl chloride chlorination, or by chlorine-methane reaction. Used as solvent, refrigerant, fire-extinguishing compound, extractant, aerosol component, chemical intermediate.

n-METHYLGLUCAMINE

$HOCH_2(CHOH)_4CH_2NHCH_3$. Off-white crystals, MP 262°F (128°C). Suggested uses as intermediate for surface-active agents, pharmaceuticals, dyes.

MITICIDES—92

MONOCHLOROBENZENE, see Chlorinated benzene

MONOETHANOLAMINE—101

$NH_2CH_2CH_2OH$. Colorless liq. BP 338.9°F (170.5°C), SG 1.0179, D 8.47 lb/gal. Made by ethylene oxide-ammonia reaction, or by nitration and reduction of propane. Used as solvent (Girdler nat.-gas purif. process); to mfr. detergents, (2-nitraminoethyl nitrate), vulcanization accelerator.

MONOHYDROXYETHYL - TRIHYDROXYPROPYL - ETHYLENEDIAMINE

$C_2H_4OH(CH_2CHOHCH_3)NCH_2CH_2N(CH_2CHOHCH_3)_2$. Light amber liquid. BP 378.5°F (192.5°C) at 0.5 mm, SG 1.057 (60°C). Potential uses as chemical intermediate, plasticizer; in mfr. surfactants, plastics, insecticides.

MONOMETHYLAL DIMETHYL HYDANTION

$(H_3C)_2C\,CONHCONCH_2OH$. White crystals. MP 230-243°F (110-117°C), D 6.67 lb/gal. Used as odorless donor of formaldehyde, disinfectant, preservative, embalming agent, soil fumigant, seed-treating agent; in mfr. textiles, washable wallpaper, adhesives.

MORPHOLINE—172, 340

$O(CH_2CH_2)_2NH$. Colorless liq. BP 263.5°F (128.6°C), FP 26.4°F (−3.1°C), SG 1.0017, D 8.3 lb/gal. Made by diethanolamine dehydration, or by di-2-chloroethyl ether-ammonia reaction. Used as solvent, corrosion inhibitor, emulsifying agent, chemical intermediate; to mfr. rubber chemicals.

MURIATIC ACID, see Hydrogen Chloride—92, 95, 96

NAPHTHAS (Cleaners naphtha, Stoddard solvent, Reformer charge stock)—209, 210, 211, 399

Liquid petroleum hydrocarbon fractions generally boiling within gasoline range. Recovered by distillation of crude oil (to get virgin naphtha) or cracked fractions. Used as solvent, dry-cleaning agent, charge stock to reforming units to mfr. high-octane gasoline.

NAPHTHALENE—222, 243, 359

$C_{10}H_8$. White flakes or powder. BP 424.2°F (217.9°C), MP 176.4°F (80.2°C), SG 1.152. Distilled from crude and cracked petroleum. Used to mfr. phthalic anhydride, β-naphthol; as antioxidant, resin solvent; to mfr. insecticides, fungicides, surface-active agents, celluloid, lacquers, varnishes.

NAPHTHENIC ACIDS—121, 122, 207, 310, 322, 327

Dark-colored liquids. BP 392-572°F (200-300°C). Chiefly alkyl cyclopentane acetic acids. Recovered from naphthenic crude oils. Used to mfr. metallo-organic salts for paint driers, additives for extreme-pressure lubricants, grease additives; as chemical intermediate, solvent.

NITRIC ACID (Aqua fortis)—40, 51, 119, 189, 190, 194, 195, 208, 216, 234, 300, 302, 304, 305, 306, 310, 326

HNO_3. Colorless-to-yellowish liq. BP 186.8°F (86°C), FP −42.3°F (−41.3°C), SG 1.530. Made by ammonia oxidation. Used as chemical intermediate, rocket-fuel component; to mfr. celluloid fertilizers.

NITROETHANE

$CH_3CH_2NO_2$. Colorless liquid. BP 237°F (114°C), FP −130°F (−90°C), SG 1.052, D 8.75 lb/gal. Made by reacting ethane with nitrogen oxides. Used as solvent, esp. for cellulosics and various resins; as chemical intermediate.

NITROGEN SOLUTIONS—6, 7, 9, 40, 41, 86, 194, 234, 300, 302, 326, 353

Mixture of ammonium nitrate (about 60 parts) and 50% aqua ammonia (about 40 parts). Used to neutralize superphosphate to mfr. fertilizer.

NITROGENOUS FERTILIZERS—208, 353, 382, 400

Fertilizers containing substantial amounts of nitrogen in form available to plants, e.g., ammonium nitrate, ammonium sulfate, ammonium phosphate. Used as plant nutrient.

NITROMETHANE

CH_3NO_2. Colorless liquid. BP 214°F (101°C), FP −20°F (−29°C), SG 1.139, D 9.5 lb/gal. Made by reacting methane with nitrogen oxides. Used as solvent, esp. for cellulosics and various other resins; as rocket fuel, chemical intermediate.

NITROPARAFFINS—70, 71

RNO_2, where R is an alkyl radical. E.g., CH_3NO_2 (nitromethane), $CH_3CH_2NO_2$ (nitroethane), etc. BP nitromethane 213.8°F (101°C), SG 1.139; BP nitroethane 237.2°F (114°C), SG 1.052. Made by paraffin hydrocarbons-nitric acid reaction. Used as solvents for nitrocellulose, cellulose acetate, other cellulosic materials, resins, waxes; as chemical intermediates.

1-NITROPROPANE

$CH_3CH_2CH_2NO_2$. Colorless liquid. BP 270°F (132°C), FP −162°F (−108°C), SG 1.003, D 8.4 lb/gal. Made by reacting propane with nitrogen oxides. Used as solvent, chemical intermediates.

2-NITROPROPANE

$CH_3CHNO_2CH_3$. Colorless liquid. BP 248°F (120°C), FP −135°F (−93°C), SG 0.992, D 8.3 lb/gal. Made by reacting propane with nitrogen oxides. Used as solvent, chemical intermediate.

para-NITROSOPHENOL

C_6H_5OHNO. Light brown crystals. MP 284°F (140°C). Made by reacting phenol with nitrous acid. Used as chemical intermediate for dyes, photographic bleaching baths; as catalyst or inhibitor in mfr. of plastics, vulcanization accelerator.

NONYL PHENOL—172

$C_9H_{19}C_6H_4OH$. Straw-colored liq. BP 563-579°F (295-304°C), SG 0.968. Made by phenol-nonylene alkylation. Used as chemical intermediate; to mfr. synthetic detergents and resins.

NYLON—(Polyhexamethylene adipamide)—50, 111

$(-CO(CH_2)_4CONH(CH_2)_6NH-)_n$. Cream-white solid. Made by "nylon salt" (made from equimolar proportions of hexamethylene diamine and adipic acid) dehydration. Used as synthetic fiber, molding powder, sheeting.

OIL TREATING CHEMICALS—361, 362

Chemical compounds or mixtures of chemicals used to treat petroleum for purpose of purification; e.g., desalting.

OLEFIN CONCENTRATE (C_7) (Mixed heptenes) —313

C_7H_{14}. Colorless liq. BP 199.4-209.3°F (93-98.5°C), FP about −182°F (−119°C), SG about 0.70. Made by dehydrogenation of C_7 paraffin hydrocarbons or separated from C_7 fraction of cracked oils. Used as chemical intermediate, particularly in Oxo process olefin-carbon monoxide-hydrogen reaction to make alcohols, aldehydes, etc.

ORTHOXYLENE (1, 2-dimethyl benzene)—310

$C_6H_4(CH_3)_2$. Colorless liq. BP 291.9°F (144.4°C), FP −13.9°F (−25.5°C), SG 0.880 (20/4°C), D 7.36 lb/gal. Made by catalytic reforming of naphthenic petroleum fractions (i.e., dehydrogenation of dimethylcyclohexane). Used to mfr. phthalic anhydride; see also Xylenes, Mixed.

OXIDES (Olefin oxides)

RO, (R an unsaturated hydrocarbin radical) e.g., CH_2CH_2O (ethylene oxide). Made by olefin oxidation, or by olefin chlorination to chlorohydrins, follwed by alkali treatment of chlorohydrins. Used to mfr. glycols, synthetic fibers, plastics, detergents.

beta, betá-OXYDIPROPIONITRILE

$NC(CH_2)_2OCH_2CH_2CN$. Colorless to pale yellow liquid. BP 248°F (120°C) at 1 mm, FP −15.3°F (−26.3°C), SG 1.0405 (30°C). Made from acrylonitrile. Used as selective solvent, chemical intermediate; in mfr. plastics, plasticizers.

PARA-CRESOL (p-Cresylic acid)—163

$CH_3C_6H_4OH$. Crystalline solid. BP 395.6°F (202°C), MP 96.8°F (36°C), SG 1.035 (20/4°C). Recovered from cracked naphthas and gas oils. Used as chemical intermediate; in mfr. antioxidants.

PARAFFIN SOLVENT, see Chlorinated paraffins —94

PARAFORMALDEHYDE (Formaldehyde polymer)—44

$HO(CH_2O)_nH$, (n ranges from about 8 to 50). White powder. MP 248-320°F (120-160°C). Made by evaporating aqueous formaldehyde solutions. Used to mfr. resins, glues.

PARA-TERTIARY-BUTYLBENZOIC ACID (p-TBBA)—270

$p\text{-}(CH_3)_3CC_6H_4COOH$. Made by oxidation of p-ter-butyl toluene (prod. by alkylation of toluene with isobutylene). Used in alkyd-resin paints; potentially to mfr. plasticizers, corrosion inhibitors, insecticides, thickening agents for paints and greases.

PARAXYLENE (1, 4-dimethybenzene)— 230, 309, 310

$C_6H_4(CH_3)_2$. Colorless liq. or crystals. BP 281.3°F (138.5°C), FP 55.8°F (13.2°C), SG 0.861 (20/4°C). Made by catalytic reforming of naphthenic petroleum fractions (contg. dimethylcylohexane). Used as chemical intermediate; to mfr. synthetic fibers and plasticizers.

PENTACHLOROPHENOL—259, 260

PENTAERYTHRITOL—161, 166, 250, 364, 381, 405

$C(CH_2OH)_4$. Colorless cryst. or white powder. BP 528.8°F (276°C at 30mm Hg), MP 500°F (260°C) SG 1.399 (25°4°C). Made by acetaldehyde-formaldehyde reaction in alkali solution. Used as chemical intermediate; to mfr. plastics, plasticizers, drying oils, insecticides.

1, 5-PENTANEDIOL (Pentamethylene glycol)

$HOCH_2CH_2CH_2CH_2CH_2OH$. Colorless liquid. BP 468.5°F (242.5°C), FP 4°F (−15.6°C), SG 0.9921, D 8.2 lb/gal. Used in mfr. of polyester and urethane resins, hydraulic fluid, lube-oil additives, antifreeze.

PERCHLOROETHYLENE (Tetrachloroethylene) —54, 94, 97, 104, 317, 389

CCl_2CCl_2. Colorless liq BP 244-252°F (118-122°C), FP −8.32°F (−22.4°C), SG 1.60-1.615, D 13.46 lb/gal. Made by acetylene-chlorine reaction. Used to mfr. trichloroethylene; as slovent.

PETROLEUM POLYMERS—174

Basically $(-CH_2-)_n$, (n may vary widely). Products may range from light liquids, such as polymer gasoline, to solid resins or plastics,

such as polyethylene. Made, in general, by polymerization of olefins, or by copolymerization of olefins and aromatics (e.g., the diolefin, butadiene, with the aromatic, styrene, to form GR-S synthetic rubber). Used as chemical intermediates, engine fuels, plastics, synthetic rubbers.

PETROLEUM RESINS—21, 120, 174, 222, 223, 242, 246, 250, 251, 252, 253, 255, 256, 257, 258, 259, 260, 287, 359

High polymers produced by polymerization of olefins or aromatics (e.g., polyethylene, polystyrene). Used as plastics.

PETROLEUM WAXES (Paraffin wax, Ceresin)—365, 369

$CH_3(CH_2)_nCH_3$. White waxy solid. MP 108-140°F (42-60°C). SG 0.880-0.915. Recovered by chilling and filtering paraffinic crude oils. Used to mfr. candles, waxed coatings, waterproof coatings, lubricants.

PHENOL (Carbolic acid)—2, 163, 188, 192, 242, 243, 250, 270, 310, 375

C_6H_5OH. White crystals. BP 358.5°F (181.4°C), MP 107-109°F (42-43°C). SG 1.071 (25/4°C). Made by benzene-sulfuric acid-caustic soda reaction (benzene sulfonate process), or by chlorobenzene-sodium carbonate (or sodium hydroxide) reaction, or benzene-hydrochloric acid-air reaction (Raschig process). Used as chemical intermediate; to mfr. phenolic resins, 2, 4-D weed killer, synthetic detergents; as solvent in petroleum refining.

PHENOL-CRESOL BLENDS

Mixtures of phenol, C_6H_5OH, and cresol, $CH_3C_6H_4OH$. Properties depend on proportions of each component (and of cresol isomers). Made or recovered from petroleum in some manner as components. Used as solvent, chemical intermediate.

PHENYL DIETHANOLAMINE—340

$C_6H_5N(C_2H_4OH)_2$. Light gray solid. BP 374°F (190°C) at 1 mm, MP 136°F (58°C), SG 1.1203 (60/20°C), D 10 lb/gal. Used as chemical intermediate, in mfr. of dyes, resins.

PHENYL ETHYL ETHANOLAMINE—340

$C_6H_5N(C_2H_5)C_2H_4OH$. Amber solid. BP 514°F (268°C) at 740 mm, MP 102°F (37.2°C), SG 1.04. Used as chemical intermediate, esp. in mfr. of dyes; as solvent.

PHOSDRIN (2-carbomethoxy-1-methylvinyl-dimethylphosphate)—274

$(CH_3O)_2[CH_3OOCCH{:}C(CH_3)O]PO$
Sold in emulsible, dust, and granular forms. Used as general-purpose insecticide, esp. for insects that have developed tolerances for other insecticides.

PHTHALIC ANHYDRIDE—19, 191, 251, 256, 310

$C_6H_4(CO)_2O$. White flakes or needles. BP 544.1°F (284.5°C), MP 267.4°F (130.8°C), SG 1.527 (4°C). Made by oxidation of naphthalene or orthoxylene. Used to mfr. synthetic resins, plasticizers, insect repellant; as chemical intermediate.

PIPERAZINE (Diethylenediamine)—172

$NH(CH_2)_2{\cdot}(CH_2)_2NH$. Colorless crystals. BP 293°F (145°C), MP 219-224°F (104-107°C). Made by ammonia-ethylene bromide (or ethylene chloride) reaction. Used in medicine.

PIPERYLENE—

$CH_2CHCHCHCH_2$. Colorless liq. BP 109.4°F (43°C). Recovered from cracked petroleum fractions or made by n-pentane dehydrogenation. Used as chemical intermediate.

PLASTICIZERS—16, 21, 130, 207, 339, 370, 371

POLYACRYLAMIDE

$(CH_2CHCONH_2)_n$. White solid. Available in following viscosity ranges: 180± 50 cps, 450 ±150 cps, and 1300± 500 cps. Made by polymerization of acrylamide. Used as soil conditioner, surface coating, thickening agent; in mfr. of adhesives, oil-well cements, coated papers, plastics.

POLYAMINES—215

$(RNH_2)_n$ (R is olefin radical). See ethylene diamine, diethylene triamine, Triethylene tetramine, teraethylene pentamine. Other polyamines include propylene diamine, tetramethylene diamine, pentamethylene diamine, and hexamethylene diamine. Used to mfr. detergents, softening agents, rubber accelerators, resins, synthetic fibers; as solvents.

POLYBUTADIENE

$(CH_2CHCHCH_2)_n$. Liq. to solid depending on chain length. E.g., $C_6H_9CHCH_2$, 3-vinylcyclohexene, made by butadiene dimerization, while octahydrobiphenyl results from its trimerization. Used in chemicals mfr.

POLYBUTADIENE-ACRYLONITRILE TYPE ACYCLIC ELASTOMERS—(Buna N synthetic rubber)—126, 165

Synthetic rubber made by copolymerization of 60 to 80 parts of butadiene with 20 to 40 parts of acrylonitrile. Used for oil-resistant synthetic rubber having good low-temperature flexibility. (see Synthetic rubber.)

POLYBUTADIENE-STYRENE TYPE ACYCLIC ELASTOMERS—(GR-S synthetic rubber)—126

Synthetic rubber made by copolymerization of about 75 parts butadiene with about 25 parts styrene. Used as natural rubber replacement in many uses. (see Synthetic rubber.)

POLYBUTENES—14, 15, 88, 310, 311

$(-CH_2CH_2CH_2CH_2-)_n$. Range from tacky viscous liquids to rubbery solids. Made by polymerization of butylenes (usually isobutenes). Used to mfr. adhesives, coatings, plasticizers, tank linings, gaskets.

POLYBUTYLENE GLYCOLS (includes Dow's "Polyglycol B500, B1000, etc.")

$HO(C_4H_8O)_nC_4H_8OH$. Viscous liquids. Pour point −10°F to 0°F; Flash point 420-435°F; SG about 0.97; D 8.1 lb/gal. Made by reacting butlyene oxide with water or a glycol-type compound. Potential uses as lubricant additives and in mfr. of polyurethane foams, insulation and structural materials.

POLYEPICHLOROHYDRIN (includes Dow's "Polyglycols 166-450, 166-900, and 166-1150.")

$HO(C_3H_5ClO)_nC_3H_5ClOH$. Viscous liquids. Pour point 21-51°F; Flash point 450-500°F; SG 1.30-1.34; D 10.8-11.2 lb/gal. Made by reacting epichlorohydrin with water or a glycol-type compound. Used as chemical intermediate, to mfr. nonflammable products, as water-insoluble solvent.

POLYESTERS—107, 138, 191

POLYETHYLENE—10, 104, 111, 149, 164, 175, 178, 193, 200, 236, 308, 324, 328, 335, 337, 338, 339, 340, 383, 387

$(C_2H_4)_n$. Ranges from colorless liquid to white solid depending on molecule size. Made by ethylene polymerization. Used as lubricants for low molecular weight polymers; as plastics for high polymers.

POLYETHYLENE GLYCOLS (includes Dow's "Polyglycol E200-E20,000" series)—172, 226, 339, 340

$HO(C_2H_4O)_nC_2H_4OH$. Viscous liquids up to mol. wts. of 1,000, solids at higher mol. wts. FP from −6°F to 58°F. Flash point 360°F to >520°F; SG 1.124-1.215; D 9.35-9.37 lb/gal. Made by reacting ethylene oxide with diethylene glycol or triethylene glycol, usually in presence of sodium-compound catalyst. Liquid products used as solvents, lubricants, plasticizers and dispersants; solid products as softening agents, lubricants. Used in textile sizes, brake fluids, antistatic agents for rubber, metal cleaning, surfactants, plastics, and polyurethane foams.

"POLYGLYCOLS" (Tradenames for Dow Chemical Co.'s polybutylene glycols, polyepichlorohydrin, polypropylene glycols, polystyrene oxide, polyethylene glycols, which see — last number is added to name to indicate average molecular weight.)

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

POLYGLYCOL ETHERS—101, 215

$RO(CH_2CH_2O)_nCH_2CH_2OH$. (R is hydrocarbon group). Made by polyglycols-alcohols reaction. Used as solvents, chemical intermediates.

POLYISOBUTLYENE, see Polybutenes—122

POLYPROPYLENE GLYCOLS (includes Dow's "Polyglycol P250, P400, etc.")

$HO(C_3H_6O)_nC_3H_6OH$. Viscous liquids. Pourpoint ranges from −94°F to −20 as avg. mol. wt. increases from 250 to 4,000; Flash point from 335°F to 440°F; SG about 1.00; D 8.3-8.4 lb/gal. Made by reacting propylene oxide with water or a glycol-type compound. Used as lubricants in mfr. of textiles, leather goods, metals and rubber; as defoamers in mfr. of ceramics, latex paints, etc.; in brake fluids; potentially in mfr. of polyurethane resins.

POLYSTYRENE—101, 102, 103, 176, 356, 389, 398

$(C_6H_5CHCH_2)_n$. Colorless solid. Made by styrene polymerization. Used as plastic for molding, extruding, or casting; to mfr. plastic products, surface finishes; in laminating fabrics.

POLYSTYRENE OXIDE (includes Dow's "Polyglycols 174-500 or 174-750")—98, 99, 103

$HO(C_6H_5C_2H_3O)_nC_6H_5C_2H_3OH$. Viscous liquids. Properties of 174-500 and 174-750, respectively: Pour point 75°F and 115°F; Flash point 430°F and 505°F; SG 1.136 and 1.152; D 9.45 and 9.59 lb/gal. Made by reacting styrene oxide with water or a glycol-type compound. Potential uses: chemical intermediate, esp. for surfactants containing hydrophobic phenyl group.

POLYVINYL CHLORIDE—94, 101, 136, 392

$(H_2CCHCl)_n$. White powder. Made by vinyl chloride polymerization. Used as plastic and plastic component (e.g., with polyvinyl acetate or Buna N); in copolymers (e.g., with acrylonitrile to give Vinyon N, a synthetic fiber).

POLYVINYL CHLORIDE RESIN—119, 148, 392

$(H_2CCHCl)_n$. White powder. Brittle at 32°F (0°C). Made by vinyl chloride polymerization. Used as plastic; to mfr. plastic sheets and films; (used less than interpolymers or copolymers containing polyvinyl chloride because of brittleness and fabrication problems).

POLYVINYLIDENE CHLORIDE—101

$(CCl_2CH_2)_n$. Crystalline solid of high tensile strength and chemical inertness. Made by vinylidine chloride polymerization. Used to mfr. plastic pipes and fittings, window screening, high tensile strength extruded products.

POLYVINYL PYRROLIDONE (PVP)

$(C_6H_9NO)_n$. White powder. SG 1.23-1.29. Made from butynediol (derived from acetylene). Used as synthetic blood plasma, substitute for natural gums; in pharmaceuticals, cosmetics, detergents, food stabilizers, dye stripping agents.

PROPANOL, normal (n-Propyl alcohol)—20, 44

$CH_3CH_2CH_2OH$. Colorless liq. BP 208°F (97.8°C), FP −197°F (−127°C), SG 0.804 (20.4°C), D 6.7 lb/gal. Made by aliphatic hydrocarbons (such as butane) oxidation. Used as chemical intermediate solvent.

PROPARGYL ALCOHOL (2-Propyn-1-ol)

$HCCCH_2OH$. Colorless liquid. BP 237°F (114°C), FP 1°F (−17°C), SG 0.9215. Made from acetylene by high-pressure synthesis. Used as corrosion inhibitor, stabilizer, chemical intermediate.

PROPIONIC ACID (Methylacetic acid)—20, 45

CH_3CH_2COOH. Colorless liq. BP 285.3°F (140.7°C), FP −7.6°F (−22°C), SG 0.987. Made by chromic acid oxidation of n-propanol, or by Fischer-Tropsch process from carbon monoxide and hydrogen. Used to mfr. propionates, emulsifying agents, solvents for cellulosics.

PROPIONALDEHYDE—20

CH_3CH_2CHO. Colorless liq. BP 119.8°F (48.8°C), SG 0.807. Made (together with allyl alcohol) by propylene oxide isomerization. Used as chemical intermediate; to mfr. plastics (e.g., polyvinyl acetals), rubber chemicals.

PROPYL ACETATE, normal—44

$C_5H_{10}OOCCH_3$. Colorless liq. BP 205-216°F (96-102°C), SG 0.897, D 7.36 lb/gal. Made by n-propanol-acetic acid reaction in presence of sulfuric acid. Used as solvent for cellulosics, natural and synthetic resins; to mfr. plastics, lacquers.

PROPYLENE (Propene)—10, 48, 89, 100, 120, 154, 156, 170, 296, 328, 393

CH_3CHCH_2. Colorless gas. BP −52.6°F (−47°C), FP −301.4°F (−185.2°C), SG 1.46 (air=1) at 0°C. Recovered from cracked refinery gases, or made by propane dehydrogenation. Used as chemical intermediate, e.g., for allyl alcohol and isopropanol; major potential use to mfr. polypropylene plastics.

PROPYLENE DICHLORIDE (1,2-Dichloropropane)—101, 104, 340

$CH_3CHClCH_2Cl$. Colorless liq. BP 205.3°F (96.3°C), −112°F (−80°C), SG 1.1583, D 9.6 lb/gal. Made by propylene-chlorine reaction. Used as solvent for waxes, oils, resins, cellulose esters and ethers.

PROPYLENE GLYCOL (1,2-Dihydroxypropane)—44, 101, 104, 340, 381

$CH_3CHOHCH_2OH$. Colorless liq. BP 370.8°F (188.2°C), SG 1.0381, D 8.6 lb/gal. Made by propylene oxide hydration. Used as solvent, for oils, waxes, resins; to mfr. hydraulic fluids, alkyl resins, plasticizers.

PROPYLENE OXIDE (Epoxypropane)—44, 101, 340, 381

$CH_3(CHCH_2)O$. Colorless liq. BP 93°F (33.9°C), FP −155.9°F (−104.4°C), SG 0.8304, D 6.9 lb/gal. Made from propylene by the chlorohydrine process (similar to mfr. of ethylene oxide and glycol). Used as chemical intermediate (e.g., propylene glycols), solvent for nitrocellulose, cellulose acetate, gums; as insecticide.

PROPYLENE TETRAMER (Dodecene)—14, 83, 115, 120, 156, 170, 261, 321, 322, 323, 327, 393

$CH_3CH(CH_2)_8CH_3$. Colorless liq. BP 415.4°F (213°C), FP −28.5°F (−33.6°C), SG 0.7600. Made by propylene polymerization. Used as chemical intermediate; in synthetic detergents mfr.

PROPYLENE TRIMER (Nonylene, Nonene)—14, 120, 156, 170, 261, 322, 327, 393

$CH_3(CH_2)_5CHCH_2$. Colorless liq. BP 302°F (150.C), SG 0.7433. Made by propylene ploymerization. Used as chemical intermediate.

RUBBER BASE PAINT (Latex paints)

Paints using latex (emulsion of natural or synthetic rubber with water) base. Synthetic latex bases may be butadiene-styrene, polystyrene, polyvinyl acetate, vinyl chloride-vinlyidene chloride, or polyacrylic polymers. Used as water-thinned paints.

RUST PREVENTIVES—12, 327

SODIUM CARBOXYMETHYL CELLULOSE—373

$[C_6H_7O_2(OH)_2OCH_2CO_2ONa]_n$, approx. formula. White granular powder. Stable without discoloration up to 347°F (175°C). Made by alkali cellulose-monochloracetic acid reaction to get carboxymethyl cellulose, followed by reaction with sodium hydroxide to convert to sodium compound. Used as film-forming agent, thickener, stabilizer, adhesive, emulsifying agent.

SODIUM CRESYLATE (Sodium carbolate)—292, 293, 295, 296, 297, 298, 311, 312

Water-soluble sodium salts of cresylic acid (unseparated cresol isomers) or aqueous solutions of such salts. Made by treating cresylic acid with aqueous sodium hydroxide. Used as source of crude cresols.

SODIUM NITRATE—9, 216

$NaNO_3$. Colorless crystals. MP 586.4°F (308°C), SG 2.267. Made by nitric acid-sodium hydroxide reaction. Used as oxidizing agent, fertilizer, refrigerant.

SODIUM SULFHYDRATE Sodium hydrosulfide)—29

$NaSH \cdot 2H_2O$. Colorless needles or lemon-colored flakes. MP about 131°F (55°C). Made by treating calcium sulfide with sodium bisulfate. Used to mfr. chemicals; in desulfurizing viscose rayon.

SODIUM SULFIDE—296, 298

Na_2S. Yellow-to-red solid. MP 1,688°F (920°C), SG 1.856. Made by passing hydrogen sulfide (from sour natural gas) through sodium hydroxide solution. Used to mfr. chemicals, rayon, rubber products; as sulfiding agent.

SODIUM SULFITE

Na_2SO_3. White crystals or powder. SG 2.6334; decomposes instead of melting. Made by sulfur dioxide-sodium carbonate reaction. Used to mfr. chemicals; as chemical reducing agent, and in treating of latex.

SOLVENTS (general)—21, 23, 40, 94, 180, 245, 246, 269, 270, 276, 285, 286, 289, 290, 291, 323, 352, 381

STYRENE (Vinylbenzene)—28, 88, 101, 104, 176, 193, 212, 223, 272, 389, 401

$C_6H_5CHCH_2$. Colorless-to-yellowish liquid. BP 293.4°F (145.2°C), FP −23.1°F (−30.6°C), SG 0.903 (20/4°C), D 7.55 lb/gal. Made by benzene-ethylene alkylation, followed by dehydrogenation of resulting ethylbenzene. Used as monomer to mfr. plastics and synthetic rubber (e.g., polystyrene, GR-S rubber).

STYRENE MONOMER, see Styrene—131

STYRENE OXIDE (1,2-Epoxyethylbenzene)—104

$C_6H_5C_2H_3O$. Colorless-to-straw colored liq. Made by addition of hypochlorous acid to styrene, followed by treating resulting chlorohydrin with aqueous alkali; or by direct epoxidation of styrene with peroxybenzoic or peroxyacetic acids. Used as chemical intermediate; to mfr. resins, water-resistant varnishes.

STYRENE RESINS—137, 147

Clear-and-colorless to opaque-and-colored resins and plastics composed of polystyrene alone or polystyrene and other polymer formers. E.g., high-impact polystyrenes are mixtures of copolymers with synthetic rubber; chemically resistant polystyrene is a copolymer with acrylonitrile.

SULFONATED ALKYL BENZENES (Alkyl benzenesulfonates)—247, 248

E.g., $C_{12}H_{25}C_6H_4SO_3Na$ (dodecylbenzene sodium sulfonate). Made by benzene-aliphatic petroleum hydrocarbons (propylene tetramer for dodecylbenzene) alkylation, followed by sulfonation of resulting alkyl benzene. Used as synthetic detergents.

SULFONATES (Petroleum sulfonates)—23, 32, 79, 84, 85, 198, 224, 277, 288, 291, 301, 310, 322, 327, 352

Petroleum hydrocarbons into which the highly polar $-SO_3OH$ group has been introduced. Classification as to aliphatic, alicyclic, aromatic, or heterocyclic depends upon type of group to which the polar group is attached. Made by sulfonating petroleum hydrocarbons. Used as surface-active, wetting, dispersing, and emulsifying agents; synthetic detergents; chemical intermediates.

SULFUR—17, 27, 72, 73, 74, 82, 118, 132, 152, 154, 155, 157, 158, 173, 179, 196, 213, 214, 218, 219, 220, 221, 233, 235, 244, 266, 267, 280, 281, 282, 283, 284, 289, 291, 312, 318, 322, 330, 334, 341, 342, 343, 363, 367, 377, 394, 395, 396, 404, 406, 411

S. Amorphous or solid yellow element. BP 832.3°F (444.6°C), MP about 248°F (120°C), SG amorphous form 1.9556; solid form 2.046. Made by conversion to sulfur of the sulfur compounds removed from sour natural gas and petroleum. Used to mfr. sulfuric acid; to vulcanize rubber; to mfr. oil-resistant synthetic rubbers, plastics, fertilizers, paper.

SULFURIC ACID (Oil of vitriol)—3, 4, 13, 23, 72, 73, 74, 192, 194, 208, 315, 316, 318, 319, 320, 333, 353

H_2SO_4. Colorless-to-brown liq. BP 599-640°F (315-338°C), MP 50°F (10°C), SG 1.834. Made by oxidation of sulfur dioxide to sulfur trioxide, followed by hydration of the trioxide with water (contact process); or by reaction of nitric oxide (from ammonia) with sulfur dioxide and water in lead chambers to form sulfuric acid and nitrous oxide (chamber process). Used to mfr. chemicals, fertilizers, paints, pigments, rayon and cellulose film.

SURFYNOLS

Tradename for series of acetylenic glycols mfd. by Air Reduction Chemical Co. BP 222-260°F; MP −40°F to 63°F. Used in nonfoaming surfactants, as pigment disperser, foam controller in mfr. of paints, textiles, coated paper; viscosity reducer in inks, vinyl plastisols.

SYNTHETIC DETERGENTS—23, 24, 40, 217, 249, 373

Liquid or solid materials capable of dissolving oily materials and dispersing or emulsifying them in water. Petroleum sulfonates, sulfates, salts, and amides are among the more common synthetic detergents. See sulfonated alkyl benzenes and Sulfonates.

SYNTHETIC LUBES—198

Hydrocarbons, polyglycols, esters, amines, imines, amides, silicones, fluorinated organic compounds. Made from petroleum hydrocarbons, natural gas, or refinery gases. Used as oils and greases where requirements of heat and chemical resistant, viscosity characteristics, service life, etc., can be met better than by petroleum oils.

SYNTHETIC RESINS (Plastics, synthetic)—148, 203, 204

Solid organic substances which can be molded or shaped by flow in some stage of mfr. E.g., cellulosics, phenolics, urea and melamide resins, polyethylene, polystyrene, polyvinyl chloride and polyvinyl esters, alkyd resins, coumarone-inndene resins. Made generally by polymerization of a monomer (e.g., ethylene) or by copolymerization of monomers (e.g., vinyl chloride-vinyl acetate); or by condensation reactions (e.g., phenol-formaldehyde). Used in molding, extruding, drawing, casting, or blowing plastic products.

SYNTHETIC RUBBER—18, 87, 120, 127, 128, 138, 142, 143, 144, 145, 146, 147, 170, 186, 187, 232, 272, 331, 351, 353, 401, 402

High polymers or copolymers possessing many physical properties of natural rubber, including elasticity and ability to be vulcanized. Made by copolymerization of butadiene and styrene (GR-S), or of butadiene and acrylanitrile (Buna N- type); or by polymerization of isobutylene with a small amount of isoprene (Butyl rubber); by reaction of sodium polysulfide with an organic dichloride (Thiokol rubber); by polymerization of dimethyl-siloxane (silicone rubber). Used as replacement for synthetic rubber in many uses; also where special properties, such as chemicals resistance, are required.

SYNTHETIC RUBBER (nitrile), see Polybutadiene-acrylonitrile type—140, 141, 186, 187, 356

TERT-BUTLYAMINE—193

$(CH_3)_3CNH_2$. Colorless liq. BP 111-5°F (44-46°C), SG 0.700 (15°C). Used as chemical intermediates; in mfr. of lube oil additives.

TERT-OCTYLAMINE

$(CH_3)_3CCH_2C(CH_3)_2NH_2$. Liquid. BP 279-289°F (137-143°C). Used as chemical intermediate; in mfr. of lube-oil additives.

TERYLENE (Dacron)—384

British name for polyester fiber made from ethylene glycol and terephthalic acid. Used to mfr. synthetic textiles.

TETRAETHYL PYROPHOSPHATE (TEPP)—40

$(C_2H_5)_4P_2O_7$. White-to-amber liq. Made by ethanol-phosphorus oxychloride reaction, or by triethyl phosphate-phosphorus oxychloride reaction. Used to mfr. insecticides; as a rodenticide.

ABBREVIATIONS

For the readers' information, abbreviations of physical properties used in the accompanying glossary are as follows: BP is boiling point; FP is freezing point; MP is melting point; SG is specific gravity; and D is density.

TETRAETHYLENE GLYCOL—104

$HO(C_2H_4O)_3C_2H_4OH$. Colorless liq. BP 621.1°F (327.3°C), FP 20.8°F (−6.2°C), SG 1.1248, D 9.4 lb/gal. Made by ethylene oxide condensation. Used as nitrocellulose solvent; plasticizer; to mfr. lacquers; potential as resin intermediate, heat-transfer medium.

TETRAETHYLENE GLYCOL DIMETHYL ETHER (Dimethoxytetraglycol)

$CH_3(OCH_2CH_2)_4OCH_3$. Colorless liquid. BP 528°F (275.8°C), FP −21.5°F (−29.7°C), SG 1.0132, D 8.4 lb/gal. Made by reaction of ethylene oxide or the preformed glycol with methyl alcohol. Used as solvent.

TETRAHYDROFURFURYL -2,4,5-TRICHLOROPHENOXYACETATE—40

Weedkiller from 2,4,5-T (2,4,5-trichlorophenoxyacetic acid)-tetrahydrofurfuryl alcohol esterification. Used when needing low volatility, high activity herbicide.

beta, betá-THIODIPROPIONITRILE

$NCCH_2CH_2SCH_2CH_2CN$. Colorless to pale yellow liquid or white crystals. MP 83.6°F (28.65°C), SG 1.1095 (30°C). Made from acrylonitrile. Used as solvent, esp. for aromatics; as plasticizer, antioxidant, chemical intermediate.

THIOPHENE—171

C_4H_4S. Colorless liq. BP 183.°F (84°C), FP −37.3°F (−38.5°C), SG 1.0644 (20/4°C). Recovered from petroleum by desulfurization processes or made by reaction of butane and sulfur. Used as chemical intermediate.

TOLUENE (Toluol)—16, 48, 83, 88, 91, 104, 133, 153, 170, 180, 222, 245, 278, 279, 280, 289, 309, 312, 322, 323, 359, 386, 399

$C_6H_5CH_3$. Colorless liq. BP 231.4°F (110.8°C), FP −139.2°F (−95.1°C), SG 0.866 (20/4°C), D 7.21 lb/gal. Made by hydroforming petroleum fractions containing methyl cyclohexane. Used as high-octane gasoline blending agent; chemical intermediate; as solvent.

meta-TOLYLDIETHANOLAMINE

$(HOC_2H_4)_2NC_6H_4CH_3$. Light gray solid. BP 566.8°F (297.1°C), MP (sets to a glass) −13°F (−25°C), SG 1.0723. Used as chemical intermediate, esp. for dyes; as emulsifier.

ortho-TOLYLPROPANOLAMINE

$(CH_3CH_2CHOH)NHC_6H_4CH_3$. Amber liquid. BP 338-356°F (170-180°C) at 20 mm, D 10 lb/gal. Used as chemical intermediate, esp. in mfr. of dyes.

TRICHLOROETHYLENE—54, 104, 389

$ClCHCCl_2$. Colorless liq. BP 189°F (87.2°C), FP −99.4°F (−73°C), SG 1.466, D 12.2 lb/gal. Made by acetylene-chlorine reaction followed by reaction of the resulting tetrachloroethane with calcium hydroxide. Used as degreasing and dry cleaning solvent, extractant for fats and oils, heat-exchange liquid.

TRICHLOROMETHYLMERCAPTO-4-CYCLOHEXENE-1,2-DICARBOXIMIDE—40

TRICHLOROMONOFLUOROMETHANE ("Freon-11")—105

CCl_3F. Colorless gas or very volatile liq. BP 74.7°F (23.7°C), FP −126.4°F (−88.0°C). Made by carbon tetrachloride-hydrofluoric acid reaction. Used as refrigerant, aerosol propellant.

TRICHLORPHENOL (2,4,5- and 2,4,6-trichlorophenol)—92

$C_6H_2Cl_3OH$. Flaky solid either yellow (2,4,6-isomer) or gray (2,4,5-isomer). Properties of 2,4,5-isomer: BP 485.6°F (252°C), MP 142-146°F (61-63°C), SG 1.678 (25/4°C). Properties of 2,4,6-isomer: BP 478-480°F (248-9°C), FP 142°F (61°C), SG 1.675 (25/4°C). Made by phenol chlorination. Used as fungicides.

TRICRESYL PHOSPHATE (TCP)—47, 130, 197

$(CH_3C_6H_4O)_3PO$. Colorless-to-yellow liq. BP 523-527°F (273-275°C at 17 mm Hg), FP −4°F (−20°C), SG 1.165. Made by cresol-phosphorus oxychloride reaction. Used as plasticizer, lubricating additive, surface-ignition and plug-fouling depressant in gasoline.

TRIDECYL ALCOHOL (Tridecanol)—120

$C_{13}H_{27}OH$. Colorless liq. or solid. BP 311-313°F (155-156°C at 15 mm Hg), FP 87°F (30.6°C). Made from C_{12} olefins by Oxo process (carbon monoxide-hydrogen reaction). Used as chemical intermediate, solvent.

TRIETHANOLAMINE—101, 340

$N(CH_2CH_2OH)_3$. Pale yellow liq. BP 680°F (360°C), FP 70.2°F (21.2°C), SG 1.12, D 9.4 lb/gal. Made by ethylene oxide-ammonia reaction. Used as solvent, corrosion inhibitor, dispersing agent in rubber; to mfr. emulsifying agents, plastics.

TRIETHYLENE GLYCOL—8, 104, 172, 215, 340, 389

$HO(C_2H_4O)_3C_2H_4OH$. Colorless liq. BP 549.3°F (287.4°C), FP 19°F (−7.2°C), SG 1.1254, D 9.4 lb/gal. Made by ethylene oxide condensation. Used as solvent, chemical intermediate; to mfr. resins, lacquers; to dehydrate natural gas.

TRIETHYLENE GLYCOL DIMETHYL ETHER

$CH_3(OCH_2CH_2)_3OCH_3$. Colorless liquid. BP 421°F (216°C), FP −50.8°F (−46°C), SG 0.9862. Made by reaction of ethylene oxide with methyl alcohol. Used as solvent.

TRIMETHYLENE CHLOROBROMIDE (1-Bromo-3-chloropropane)

$CH_2ClCH_2CH_2Br$. Colorless liquid. BP 290.3°F (143.5°C), SG 1.597. Used as chemical intermediate, esp. in mfr. of cyclopropane and other pharmaceuticals.

TRIMETHYLOLPROPANE (Hexaglycerine; 2,2-dihydroxymethyl-1-butanol)

$C_2H_5C(CH_2OH)_3$. White flaked solid. MP 135-8°F (57-59°C). Made by aldol condensation of butyraldehyde and formaldehyde. Used in mfr. of plastics, varnishes, drying oils, surface-active agents, humectants, explosives.

TRIOXANE (Metaformaldehyde)—44

$(CH_2O)_3$. White crystals. BP 239°F (115°C), MP 143.6°F (62°C). Made by formaldehyde distillation. Used as chemical intermediate, odorless and nonluminous fuel.

TRIS(HYDROXYMETHYL)AMINOMETHANE

$(CH_2OH)_3CNH_2$. White Crystals. BP 426-8°F (219-220°C) at 10 mm, MP 240-2°F (171-72°C). Used as chemical intermediate, absorbent for acidic gases, emulsifying agent.

UREA—6, 7, 53, 90, 151, 272, 300, 302, 306, 333

NH_2CONH_2. White crystals or powder. Decomposes before boiling. MP 270.9°F (132.7°C), SG 1.335 (20.4°C). Made by ammonia-carbon dioxide reaction. Used as chemical intermediate, fertilizer; to mfr. plastics, adhesives, fire-resistant paints.

VINYL ACETATE—1, 45, 338

$CH_3COOCHCH_2$. Colorless liq. BP 161.2-163.4°F (71.8-73°C), FP −148.4°F (−100.2°C), SG 0.9335-0.9345, D 7.70 lb/gal. Made by acetylene-acetic acid reaction. Used as monomer to mfr. vinyl plastics.

VINYL CHLORIDE (Chloroethylene)—94, 100, 104, 148, 193, 338

CH_2CHCl. Colorless gas (or liq. under pressure). BP 7°F (−13.9°C), FP −255.5°F (−159.7°C), SG 0.9121, D 7.6 lb/gal. Made by acetylene-hydrogen chloride reaction, or by catalytic cracking of ethylene dichloride. Used as monomer to mfr. vinyl plastics, refrigerant.

VINYL PROPIONATE

$CH_2CHCOOCH_2CH_3$. Liquid with max. APHA color of 10. BP 202.8°F (94.9°C), SG 0.9170-80. Made by acetylene-propionic acid reaction. Used to mfr. vinyl copolymers, esp. for use as adhesives, emulsion paints, plastics; in synthetic rubbers, protective coatings, chewing-gum resins.

VINYL RESINS—137, 340

Plastics made by polymerization or copolymerization of vinyl compounds, such as vinyl chloride and vinyl acetate. Used in molding, casting, drawing, extruding, or blowing plastic products.

VINYL TOLUENE, see Methyl styrene—101

VINYLIDENE CHLORIDE (asymmetric Dichloroethylene)—104

CCl_2CH_2. Colorless liq. BP 98.6°F (37°C). Made by treating 1,1,2-trichloroethane with caustic soda. Used as polymerization monomer to mfr. polyvinylidene chloride and interpolymers with vinyl chloride (Saran, Velon).

VINYLPYRIDINE TYPE ACYCLIC ELASTOMERS—137

Copolymers made from butadiene and 2-vinylpyridine. Properties are superior in some respects to GR-S rubber, esp. in flexing-hysteresis characteristics.

WETTING AGENTS

XYLENES, Mixed (o-, m-, and p-Dimethylbenzenes)—16, 48, 88, 133, 153, 170, 222, 245, 278, 279, 289, 310, 312, 322, 323, 359, 386, 399

$C_6H_4(CH_3)_2$. Colorless liq. BP 279-284.9°F (137.2-140.5°C) SG 0.865-0.870, D 7.2 lb/gal. Made by catalytic reforming of naphthenic petroleum fractions (contg. dimethylcyclohexane). Used as chemical intermediate, solvent; to mfr. xylidines (aviation-gasoline blending agents), lacquers, enamels.

Who's Who in Petrochemical Service Firms

Information compiled by PETROLEUM PROCESSING. Not to be construed as showing total activities of availabilities of the listed companies in related or other fields.

Services listed are in response to question . . . "Please list only those (petrochemicals) for which you have done or are doing engineering, design or construction (and other services)."

ALEXANDER, INC, NORMAN 80 East Jackson Blvd, Chicago 4, Illinois; ph Harrison 7-5560. A. J. Chidichimo, Pres. Affil, Donald H. Oliveri, Architect, 10016 Ave L, Chicago, Illinois.

Services—plot plans, plant layouts, structures, buildings, pressure vessels, roadways, pipeways, and other drawing & design services.

ARMISTEAD & CO, GEORGE 1200 Eighteenth St, NW, Washington DC; ph Republic 7-1580. Contact, Richard O. Burk, Senior Engr. Branch office, Tamion Bldg, 2 Spyromiliou Street, Athens, Greece.

Services—consult, engrg, process & mech design, economic & market surveys. Provides engrg & design for alkylate—gasoline, ben-

zene, butadiene, petroleum polymers, sulfur (Claus), toluene, xylenes, urea (Inventa).

ATLANTIC REFINING CO Research & Development Dept, 2700 Passyunk Ave, Philadelphia, Pa; ph HOward 5-2345. Sales office at above address, J. A. Nevison, Licensing Div Section Leader; J. M. McIlvain, Hamburg 1, Spaldingstrasse 64, Germany.

Services—licensing, advis, consult for C_8 Aromatic Isomeration (ethylbenzene, ortho-meta-, and para-xylene).

BECHTEL CORP 220 Bush St, San Francisco 4, Calif; ph Douglas 2-4032. Engrg & sales offices at above address, C. T. Draney, VP; 485 Lexington Ave, New York 17, NY, D. K. Finlayson, Eastern Representative; 1300 Main St (sales only), Houston 2, Tex, W. E. Arthur, Gulf Coast Representative. Subsids, Canadian Bechtel Ldt, Toronto & Vancouver, Canada; Bechtel International Corp, San Francisco, Calif; Bechtel International Ltd, London, England. Affil, Bechtel Associates, 485 Lexington Ave, New York 17, NY.

Services—process design, mech engrg, procurement, constr, consult & advis for all types of petrochemical plants, according to specific processing requirement of the client.

BLAW-KNOX CO Chemical Plants Div, 300 Sixth Ave, Pittsburgh 22, Pa; ph EXpress 1-1244. M. M. Ramer, Mgr of Sales Promotion. Engrg offices at Pittsburgh address & at 180 N Wabash Ave, Chicago 1, Illinois (ph RAndolph 6-7014). Sales offices, 230 Park Ave, New York, NY, H. F. Oswald & J. Woade; Blackhorse Pike & Maple Ave, Haddon Heights, NJ, E. P. Additon; 1000 Vermont Ave, NW, Washington DC, J. F. Simmons (ph REpublic 7-3142); Brown-Marx Bldg, Birmingham, Ala, F. A. Weil (ph Birmingham 54-7661); 36 S Wabash Ave, Chicago, Illinois, J. L. McPherson.

Services—licensing, advis, consult, process design, mech engrg constr, R&D, economic surveys, etc. Provide licensing, engrg, design & constr for SBA Acetylene & Vinyl Acetate, Montecatini Ammonia & Nitric Acid, Hercules Hydrogen & Phenol, and own processes for petroleum poly & resins, polyesters, polystyrene, polyvinyl chloride & its resin, vinyl chloride & resins, synthetic resins. Provides engrg, design & constr for additives—cutting oil, additives—lube oils, alkylate—gasoline, ammoniating solutions, ammonium nitrate, aromatic & aliphatic solvents, aromatic distillate, benzene, benzene hexachloride, butylene-1, butylene-2, carbon monoxide, chlorinated benzene, cumene, DDT, dry ice, Epon resins, ethyl chloride, explosives, hydrogen chloride, hydrogen sulfide, insecticides, latex, lindane, muriatic acid, naphthas, nitrogen solutions, nitrogenous fertilizers, polybutadiene - styrene elastomers, rubber base paints, solvents, styrene resins, sulfonates, sulfur, synthetic detergents, synthetic rubber.

BOVAY, H. E., JR, Consulting Engineers 5009 Caroline St, Houston 4, Tex; ph JAckson 9-4921. Branch engrg & sales offices, West 933 Third Ave, Spokane 4, Wash (ph MAdison 4-3119); 5217 Government St, Baton Rouge, La (ph Dickens 8-3119).

Services—consulting engrs, design, mech, elect, structural, economic surveys, industrial consultants. Provides engrg & design for petrochemical styrene monomer process.

CALIFORNIA RESEARCH CORP 200 Bush St, San Francisco 20, Calif; ph SUtter 1-6867. Parent, Standard Oil Co (Calif). Engrg offices, 576 Standard Ave, Richmond 1, Calif; PO Box 446, La Habra, Calif; PO Box 97, El Segundo, Calif. Sales office, 200 Bush St, San Francisco 20, Calif. W. H. Claussen, Mgr Invention Development.

Services—company grants licenses under its patent assets (with engrg & design) for Cyclic Adsorption for recovery of benzene, toluene & xylenes, and for Calif Poly Process & Calif Bulk Acid Poly for petroleum polymers.

CATALYTIC CONSTRUCTION CO 1528 Walnut St, Philadelphia 2, Pa; ph Kingsley 5-7500. Parent, Houdry Process Corp. Subsid, Catalytic Construction of Canada Ltd, 600 Vidal St South, Sarnia, Ontario, Canada. Engrg offices at Philadelphia & Sarnia addresses. Sales offices, at Philadelphia address, H. C. Hamilton; 1810 Oakdale Ave, Toledo, Ohio, R. R. Blickle; 1755 S Quincy St, Tulsa, Okla, W. F. Sims.

Services—process design & development, economic studies, engrg, constr, procurement, maintenance, pilot plant investigation. Provides engrg, design & constr for alkylate—detergent, alkylate—gasoline, ammonia, aromatic fractions, butadiene, ethyl chloride, ethylene dichloride, dibasic acid, polystyrene, toluene, vinyl chloride, hydrogen, insecticides, urea, latex; and engrg & design for dichlorodifluoromethane, diethanolamine, monethanolamine, butylene-1, butylene-2.

Who's Who in Petrochemical Service

Advisory & consulting
Licensing
Process design
Mechanical Engineering
Construction
Other services

CHEMICAL CONSTRUCTION CORP 525 West 43rd St, New York 36, NY; ph LOngacre 4-9400. Branch sales offices in Paris, Johannesburg & Tokyo. Parent, Electric Bond & Share Co. Subsid, Chemical Construction (Canada) Ltd, Toronto, Canada. Affil, Chemical Construction (Great Britain) Ltd, London, England.

Services—design, engrg, constr & licensing for BASF Acetylene process. Provides design, engrg & constr for acrylonitrile, ammonia, ammonium nitrate, ammonium sulfate, formaldehyde, hydrogen, hydrogen cyanide, methanol, nitric acid, nitrogenous fertilizers, phenol, sulfuric acid, urea.

CHEMICAL & INDUSTRIAL CORP 256 McCullough St, Cincinnati 26, Ohio; ph EAst 1-8285. Angus M. Taylor, Jr., Director of Sales. Subsid, The Chemical & Industrial Construction Co, at above address.

Services—licensing, advis, consulting, process design, mech engrg, constr, R&D, economic surveys, etc.

COMMERCIAL SOLVENTS CORP 260 Madison Ave, New York 16, NY. A. L. Lukens, Licensing Coordinator, engrg office, Terre Haute, Ind.

Services—licensing, process design, constr and R&D in addition to mfg & sales operations. Process licenses, engrg & design for ammoniating solutions, Stengel ammonium nitrate, amyl acetates, benzene hexachloride, butyl acetate, carbon blacks, dimethyl formamide, dry ice & liquid carbon dioxide, formaldehyde, hydrogen, lindane, methyl amine, nitrogen solutions, nitrogenous fertilizers, pentaerythritol & solvents.

CRAWFORD & RUSSELL INC 695 Summer St, Stamford, Conn; ph Davis 4-7303. S. T. Russell, Pres.

Services—licensing, advis, consulting, process design, mech engrg, constr, R&D, economic surveys. Provides engrg, design & constr for polyvinyl chloride, vinyl chloride monomer, butadiene-styrene type elastomers (GRS rubber), butadiene acrylonitrile, elastomers (Buna N rubber), vinyl resins, polyvinyl acetate, acrylic polymers, latex, sodium sulfide, pentaerythritol, phosgene, latex paints.

DAY & ZIMMERMANN, INC 1700 Sansom St, Philadelphia 3, Pa; ph LOcust 4-4141. H. D. Johnson, Jr, Engrg Mgr. Branch sales offices, 231 S LaSalle St, Chicago 4, Illinois (ph State 2-2390); 500 Fifth Ave, New York 36, NY (ph LOngacre 3-6808).

Services—consult, process design, mech engrg, constr, economic surveys, industrial engrg, reports. Licenses acetylene process. Provides engrg, design & constr for additives—lube oil, carbon blacks, explosives, isobutylene, latex, petroleum polymers, petroleum resins, polyisobutylene, polyvinyl chloride, polyvinyl chloride resins, styrene resins, synthetic resins, synthetic rubber, vinyl resins, polybutadiene-styrene elastomers, polybutenes, polyvinylidene chloride, sulfuric acid; and const for alkyl aromatic detergents.

DRAVO CORP Machinery Div, Dravo Bldg, 5th & Liberty Aves, Pittsburgh 22, Pa; ph EXpress 1-2600.

Services—constr & pipe fabrication. Provide constr for hydrogen peroxide, trichloroethylene.

DRESSER ENGINEERING CO PO Box 2518, Tulsa 1, Okla; ph LUther 7-2411. Chas. A. Cone, VP.

Services—consulting, process design, mech engrg, and constr for gas treating, compression, dehydration and LPG recovery.

DUSHELL ENGINEERING, INC 331 North Waco Ave, Wichita 2, Kans; ph HO 4-0317. F. D. Fuqua, Exec VP. Affil, Morrison Construction Co, 1834 Summer St, Hammond, Ind.

Services—Advis, consult, economic studies, process design, mech engrg, constr. Provide engrg, design & constr for aliphatic naphthas, alkylate, benzene, sodium sulfate, toluene, xylenes.

ESSO RESEARCH & ENGINEERING CO 15 West 51st St, New York 19, NY; ph Plaza 7-3000. P. H. Holt, 2nd, Mgr, Process Licensing. Parent, Standard Oil Co (NJ). Subsids, Esso Research Ltd, 33 Davies St, London, W.1, England; Jasco, Inc, 15 West 51st St, New York 19 NY. Affils, Standard Oil Co (NJ) & its affils.

Services—only activity for non-affiliated companies is licensing, including butadiene by Butene Dehydrog, butadiene recovery by Cuprous Ammonium Acetate Extract, Isobutylene Extract, styrene by Ethylbenzene Dehydrog, Butyl Rubber.

FARNSWORTH & CHAMBERS CO, INC PO Box 74, Houston, Tex; ph Mission 4-5281. A. C. Lederer, VP. Affil, Southern Industrial Piping Co, Houston, Tex.

Services—genl engrg (industrial & mech, structural, elect & architectural design), constr, cost estimates & economic surveys. Provides engrg, design and constr for polyethylene—low pressure, acrylate, polybutane; and constr for polyethylene—hi pressure, aldehydes, alcohols, amines, deodorizers, acetic acid, ketenes, acetylene.

FLUOR CORP, LTD 2500 S Atlantic Blvd, Los Angeles 22, Calif; ph ANgelus 2-6111. W. R. Walker, Supervisor of Public Relations. Engrg offices at Los Angeles address and 3137 Old Spanish Trail, Houston 21, Tex. Sales offices at Los Angeles address; 1594 The Houston Club Bldg, Houston, Tex; 589 Fifth Ave, New York, NY; PO Box 10396, Pittsburgh, Pa, P. C. McKengie. Subsids, Fluor Corp of Canada Ltd, 200 Bloor St East, Toronto, Ont; Fluor Maintenance, Inc, 430 Main St, Martinez, Calif. Affils, Singmaster & Breyer, Inc, Graybar Bldg, 420 Lexington Ave, New York 17, NY; H.G. Acres & Co, Niagara Falls, Ontario, Canada.

Services—design, engrg, constr of process plants for petroleum, chemical, power industries; manufacture various wood & metal products for same industries; contract research for industry. Provide licensing, engrg & design, constr for ammonia, nitric acid, nitrogenous fertilizers, sulfuric acid, sulfur, urea, vinyl chloride; and engrg & design & constr for acetylene, alkyl aromatic detergent, alkylate (detergent), alkylate (gasoline), ammoniating solutions, ammonium nitrate, ammonium phosphate, ammonium sulfate, benzene, butadiene, butylenes, carbon monoxide, carbon tetrachloride, dry ice, ethylene, ethylene oxide, ethylene glycol, hydrogen, methanol, naphthas, nitrogen solutions, poly-ethylene, phthalic anhydride, propylene trimer, propylene tetramer, synthetic lubes, toluene, xylenes.

FOSTER WHEELER CORP 165 Broadway, New York 6, NY; ph Worth 4-4400. Engrg offices at 255 Hungtion Ave, Boston 16, Mass (ph Commonwealth 6-5617); 6300 Bowling Green, PO Box 14454, Houston 21, Tex (ph Jackson 6-2211); 224 South Andrews Ave, Ft. Lauderdale, Fla (ph Jackson 4-3323-241); 333 North Broad St, Elizabeth, NJ (ph Elizabeth 4-9639). Sales offices, 80 Federal St, Boston 10, Mass, Al Downam (ph Hancock 6-0117); 105 W. Adams St, Chicago 3, Illinois, J. Kenney (ph Randolph 6-8673); Leader Building, Cleveland 14, Ohio, F. Balthasar (ph Main 1-8225); 505 North Ervay St, Dallas 1, Tex, J. Bell (ph Riverside 8-2442); Michigan Building, Detroit 26, Mich, Hugh Dean (ph Woodward 1-4495); 711 Maine St, Suite 905, Houston 2, Tex, B. Gilligan (ph Capital 2-7364); 1017 Dwight Bldg, Kansas City 5, Mo, John Taylor (ph Harrison 1-1575); 1004 Baltimore Ave, Kansas City 5, Mo, John Taylor (ph Harrison 1-6545); 714 W Olympic Blvd, Room 307, Los Angeles 15, Calif, Shuman H. Moore (ph Richmond 9-7839-7830); Packard Bldg, Philadelphia 2, Pa, N. A. Scott Jr. (ph Rittenhouse 6-2888 & 6-0463); Oliver Bldg, Pittsburgh 22, Pa, C. Russel (ph Atlantic 1-4887); 36 Winthrop St, Rochester 7, NY, H. J. Mault (ph Baker 5-8589); 461 Market St, San Francisco 5, Calif, R. Spear (ph Garfield 1-6042); Tower Bldg, Washington 5, DC, H. Carleton (ph District 7-2022); Vance Bldg, 3rd & Union, Seattle, Wash, S.P. Trewin (ph Main 7434). Subsids, Foster Wheeler Ltd, Foster Wheeler House, 3, Ixworth Place, London, S.W. 3, England; Foster Wheeler Ltd, Canada, Northern Hardware Bldg, Edmonton, Alberta; 1 Kline

Street, Halifax, N.S.; 4795 St. Catherine St W, Montreal 6; Commercial Life Bldg, 1303 Yonge St, Toronto 7, 539 E Hastings St, Vancouver 4, B.C.; 211 Portage Ave, Winnipeg 2, Manitoba; Societe Foster Wheeler Francaise, 6, Rond Point des Champs Elysees, Paris VIII, France; General Regulator Corp, 165 Broadway, New York 6, NY.

Services—licensing, advis, consult, process design, mech engrg, constr, R&D, economic surveys chemical plants, nuclear energy plants, and specialized equipment for these. Provides licensing, engrg & design, and constr for ammonia—Casale, urea—Pechiney, methanol—Casale, synthesis gas & hydrogen—Texas Co partial oxidation, butyl rubber—Esso Research; and engrg & design & constr for butadiene, ethylene, phenol, phthalic anhydride, cyanate intermediates; and constr for ethyl chloride, ethylene oxide.

GRAFF ENGINEERING CORP 413 Meadows Building, Dallas 6, Tex; ph EMerson 8-3760. Lucius Hannon, Jr, VP. Affil, International Process Equipment Corp, Dallas, Tex.

Services—Consult, process design, mech design, procurement of H_2S removal units and sulfur recovery plants. Provide engrg & design & constr for sulfur—modified Claus, hydrogen sulfide—amine process.

HEDRICK ENGRG CORP, WYATT C. 5214 San Jacinto St (PO Box 11331), Houston 1, Tex; ph JAckson 3-4451. G. M. McGranahan, Pres. Subsid, Atlas Constructors, Inc, at above address.

Services — consult; studies of processing, feasibility, raw materials & site location; appraisals; project design; process, civil, mech, elect, instrument engrg; purchasing. Provide engrg & design for ethylene, ethylene oxide, ethylene glycol, chlorinated aromatics, styrene, synthetic rubbers, organic sulfides, polyethylene, insecticides, butadiene, butylene-1, butylene-2.

HOLMES & NARVER, INC 828 S Figueroa St, Los Angeles 17, Calif; ph TRinity 8201. Engrg & sales offices at above address, C B Roen, Mgr, Petro-Chemical Div. Sales offices, 1737 "H" St, NW, Washington DC (ph District 7-1405), S. H. Wright; 1210 Auahi St, Honolulu 14, TH (ph Honolulu 5-8271), J. V. Hogan.

Services—consult, site selection, economic studies, master planning & process design; mech, architectural, structural, sanitary & elect design; constr & facility operation. Provide engrg, design & constr for alkylate—detergent, alkylate—gasoline, ammonia, ammonium nitrate, aromatic distillates, benzene, butadiene, cumene, cyclohexane, chlorobenzene, ethyl-benzene, ethylene, ethylene oxide, formaldehyde, hydrogen, hydrogen cyanide, hydrogen chloride, isopropanol, methanol, hydrogen sulfide, nitric acid, polystyrene, propylene tetramer, propylene trimer, solvents, styrene, sulfonated alkyl benzenes, sulfonates, sulfur, sulfuric acid, vinyl chloride, xylenes.

HOUDRY PROCESS CORP 1528 Walnut St, Philadelphia 2, Pa; ph PEnnypacker 5-9490. Subsid, Catalytic Construction Co.

Services—licensing, consult, process design, mech engrg, R&D, economic surveys, contract research. Provides licensing, engrg & design (with constr through Catalytic Construction Co) for Houdriforming to make aromatic solvents, hydrogen, benzene, toluene & xylenes; Houdry Dehydrog to make butadiene, butylene-1, butylene-2, ethylbenzene, isobutylene, isoprene, piperylene & propylene.

JACOBS ENGINEERING CO 774 East Green St, Pasadena, Calif; ph RYan 1-9373. Engrg & sales office, 600 Sixteenth St, Oakland, Calif (ph TEmplebar 2-5391), Dr. T. Dorris.

Services — consult, research management, feasibility studies & market surveys, process design & mech engrg, detailed piping, structural & civil design. Provide engrg & design for chlorinated hydrocarbons, ethylene, hydrogen.

KAIGHIN & HUGHES, INC Atlantic & Spencer Sts (PO Box 952), Toledo 1, Ohio; ph WAlbridge 5671. Engrg & sales offices at above address, A. Abboud, Mgr Chem & Refy Div; 1417 E Archwood Ave, Akron, Ohio; 726 Stanton St (engrg only), Toledo, Ohio. Subsid, K & H Engineering Co, Trugas Constructors, Inc.

Services—mech engrg & contracting, pipe & vessel fabricators for process industry.

KAISER ENGINEERS 1924 Broadway, Oakland 12, Calif; ph TWinoaks 3-4600. Branch sales offices, 300 Park Ave, New York 22, NY (ph PLaza 9-1100); Room 505 Grant Bldg, 330 Grant St, Pittsburgh 19, Pa (ph Atlantic 1-7992); 1625 "I" St NW, Washington DC (ph STerling 3-1555); Casilla No. 2591, Correo Central, Buenos Aires, Argentina (ph 30-6001); 16 Dominion Square Bldg, Montreal, PQ, Canada (ph UNiversity 6-9527). Parent, Henry J. Kaiser Co. Subsids, Kaiser Engineers International, Inc; Kaiser Engineers Overseas Corp; Henry J. Kaiser Co (Canada) Ltd; Henry J. Kaiser Construction Co; Foothill Electric Co.

Services — advis, consult, process design, mech engrg, constr, procurement, economic surveys, etc. Provides engrg, design & constr for ammonium sulfate, aromatic distillate, aromatic solvents, aromatic tars, benzene, cresols, hydrogen, hydrogen sulfide, naphthas, naphthalene phenol, polystyrene (constr only), pyridine, sulfuric acid (constr only), toluene, xylenes.

KELLOGG CO, M. W. 711 Third Ave, New York 17, NY; ph OXford 7-5200. Engrg & sales offices at above address, R. J. Wolf (sales); Kellogg International Corp, Kellogg House, 7-8 Chandos St, Cavendish Square, London W. 1, England (ph Museau 4010), R. M. Serre (sales). Sales office Companhia Kellogg Brasileira, Avenida Rio Branco 57; 16° Andar, Rio de Janeiro, Brazil (ph 43-2042 or 43-3872), D. R. McKinney; Kellogg Pan American Corp (New York City address & ph as above), M. J. Carnesale; The Canadian Kellogg Co Ltd, 33 Bloor Street East, Toronto 5, Canada (ph WAlnut 4-4426), H. W. Wurdemann; Societe Kellogg, 28 Rue Bayard, Paris 8e, France (ph Balzac 2189), B. E. Sewell; M. W. Kellogg Co, 1407 Russ Bldg, San Francisco, Calif (ph YUkon 6-4979), W. R. Dunn; M. W. Kellogg Co, 453 Esperson Bldg, Houston 2, Tex (ph Capitol 8-6481), W. T. McCay. Subsids, listed with sales offices. Parent, Pullman, Inc.

Services—licensing, advis, consult, process design, mech engrg constr, R&D, economic surveys, etc. Provide engrg design & constr including phthalic anhydride, cumene, phenol, ethylene, polyethylene, oxo alcohols, methanol, toluene, ethyl chloride, hexylene glycol, hydrogen chloride, butadiene, detergents, sulfuric acid.

KIDDE CONSTRUCTORS, INC, WALTER Southwest Div, 1205 Holman Ave (PO Box 8347), Houston 4, Tex; ph JAckson 9-2644. Engrg & sales offices at above address & 811 Louisiana Natl Bank Bldg, Baton Rouge, La. Subsid, Process Installations, Inc., 1205 Holman Ave, Houston 4, Tex.

Services—consult, site surveys, economic surveys, process design, engrg (structural, mech, process & elect), estimating, procurement, constr, process installation. Provide engrg, design & constr for alcohols, ammonium sulfate, dry ice & liquid carbon dioxide, Epon resins, epoxy resins, latex, methanol, petroleum resins, GR-S synthetic rubber, polybutadiene-styrene elastomers, synthetic resins; and engrg & design for petroleum waxes, polystyrene, styrene resins, synthetic rubber (Buna N), synthetic rubber (nitrile).

KOPPERS CO, INC Engrg & Constr Div, Koppers Bldg, Pittsburgh 19, Pa; ph Express 1-3300. Dr. W. C. Rueckel, VP & Genl Mgr, E&C Div.

Services—licensing, consult, process design, mech engrg, constr, R&D, economic surveys for gas production and reforming plants, organic and inorganic chemical plants. Provide licensing, engrg, design & constr for acetylene, ammonia-SBA, benzene, butadiene, ethylbenzene, ethylene, polyethylene, polystyrene, styrene, toluene, xylene; and engrg & design and constr for ammonium sulfate, naphthalene, phthalic anhydride.

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MACCO CORP 14409 South Paramount Blvd, Paramount, Calif; ph NEvada 6-1261 & MEtcalf 0-5801. E. Van Dornick, VP. Branch sales offices, 630 Fifth Ave, New York, NY, A. H. Chapman; Canadian Macco, Walkem & Walkem, 1501 Standard Bldg, Vancouver 2, B.C., Canada. Subsid, Diversified Builders, Inc, Montebello, Calif.

Services—advis, consult, constr, process design, mech engrg, economic surveys, etc.

MEKLER, L. A., Consulting Engineer 525 Lexington Ave, New York 17, NY; ph MUrray-Hill 8-1793.

Services—consult, process design, R&D.

NOFSINGER CO, C. W. 1311 Rialto Bldg, 906 Grand Ave, Kansas City, Mo; ph BAltimore 1-4146. Sales offices at 609 S Grand Ave, Los Angeles 17, Calif, A. R. Chandler, West Coast Sales Representative. Affil, Nofsinger-Long Co.

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PHILLIPS PETROLEUM CO Perco Div, Bartlesville, Okla; ph 6600, ext 7446. A. D. Fischbeck, Mgr.

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PONA ENGINEERS, INC PO Box 8217, Houston 4, Tex; ph Jackson 6-2788. C.S. Faulkner, Pres. S.W. Smith, VP. Engrg and sales office at No. 8 Chelsea Place, Houston, Tex. Subsid, Pona Constructors, Inc, No. 8 Chelsea Place, Houston, Tex. Affil, Pona Engrs (Sask.) Ltd, 1401 Scarth St, Regina, Sask., Canada.

Services—economic surveys and evaluations, consult, process design, mech design & constr. Provide engrg, design & constr for BTX aromatics—UOP Udex; aliphatic naphthas; aromatic & aliphatic solvents; DDT & BHC insecticides — Stauffer; propylene; propylene tetramer & trimer—UOP & California Research; and engrg & design for gasoline alkylate (HF & H_2SO_4)—UOP & Phillips; detergent alkylate —Phillips; aromatic distillate; chloral; cresols; petroleum waxes; sulfur.

PRENGLE, DUKLER & CRUMP 5417 Crawford St, Houston 4, Tex; ph JAckson 4-6777.

Services — advis, consult, process design, mech engrg. R&D, economic surveys for chemicals, petrochemicals & petroleum products.

PRITCHARD & CO, J. F. 4625 Roanoke Parkway, Kansas City 12, Mo; ph Jefferson 1-9500. Engrg & sales offices, 35 E Wacker Drive, Chicago 6, Illinois (ph Dearborn 2-4896), W. W. Bodle; 2261 W. Holcombe Blvd, Houston 5, Tex, PO Box 20001 (ph Mohawk 4-3445), W. H. MacKay & R. E. Bradley; 405 Lexington Ave, New York 17, NY (ph MUrrayHill 4-0082), A. B. McClelland; 905 Union Trust Bldg, Pittsburgh 19, Pa (ph Express 1-0616), C. V. Spangler. Affil, Poole-Pritchard Ltd, Calgary, Alta, Canada. Subsid, J. F. Pritchard & Co of Calif.

Services—process design, mech engrg, constr.

PROCON, INC 1111 Mt Prospect Road, Des Plaines, Illinois; ph VAnderbilt 4-3171. Branch engrg offices, 23 E Jackson, Chicago 4, Illinois (ph HArrison 7-9632). Parent, Universal Oil Products Co. Subsids, Procon International, S.A., Santiago de Cuba; Procon (Canada) Ltd, Toronto 18, Ontario, Canada; Procon (Great Britain) Ltd, Bush House, Alkwych, London W.C. 2, England.

Services—engrg, design & constr for alkylate, aromatic & aliphatic solvents, aromatic distillates, benzene, butadiene, butylene-1, butylene-2, cumene, cyclohexane, ethylene, ethylbenzene, hydrogen sulfide, naphthas, naphthalene, para-cresol, petroleum polymers, propylene, solvents, styrene, toluene, xylenes.

PROCTOR ENGINEERING CO PO Box 7348, Tulsa, Okla; ph Riverside 3-1354. R. C. Proctor, owner.

Services—advis, consult, constr, process design, mech engrg for petrochemical sulfur.

REFINERY CONSTRUCTION CO OF HOUSTON PO Box 6734, Houston 5, Tex; ph Jackson 8-4261. Affil, Industrial Gencon Co, PO Box 6554, Houston 5, Tex.

Services—process design, mech engrg, constr, plant maintenance, management, economic surveys. Provide engrg, design & constr for butadiene, isopropyl alcohol, toluene, xylene, benzene; and engrg & design for butane, butylene; and constr for polyethylene, styrene, propane, Epon resins, ammonia.

REFINERY ENGINEERING CO. (Treco) PO Box 1558, Tulsa, Okla; ph LUther 4-3461. H. V. Flemming, Jr, VP. Branch engrg & Sales office (Refinery Engrg Ltd) PO Box 6, Terminal A, Toronto, Ont, Canada. Parent, Vitro Corp of America.

Services—advis, consult, contr, process design, mech engrg. Provide engrg, design & constr for aliphatic naphthas, sulfonated alkyl benzenes, alkylate—gasoline, aromatic solvents and distillate, benzene, cresylic acids, Epon (epoxy) resins, sulfur, toluene, mixed & separate xylenes, polyisobutylene, and cumene codimer.

SCIENTIFIC DESIGN CO, INC 2 Park Ave, New York 16, NY; ph MUrrayHill 9-3176. Engrg office, 880 Bergen Ave, Jersey City 6, NJ. Subsids, SD Plants, Inc (construction) & Chempatents, Inc (patent licensing), same address as above. Affils, Scientific Design & Engineering Co, Inc, 33 Central Ave, Panama City, RP (admin offices); 80 King St, W, Toronto 1, Ontario; and Societe Francaise des Services Techniques SARL, 52 Champs-Elysees, Paris 8, France.

Services—product & process development, plant design & constr, licensing & consult. Provide licensing, engrg, design & constr for anhydrides, aromatic & aliphatic solvents, cumene, diethylene glycol, ethanol, dimethyl terephthalate, ethyl benzene, esters, ethylene oxide, isophthalic acid, maleic anhydride, oxides (olefins), phthalic anhydride, polyvinyl chloride, polyvinyl chloride resin, styrene, styrene monomer, alcohols, sulfur, synthetic resins, vinyl chloride & vinyl resins. Same services (with associative licensing) for carbon tetrachloride, chlorinated solvents, chloroform, ethanolamines, hexachlorbenzene, methyl chloride, methylene chloride, perchloroethylene, & solvents. Provide engrg, design & constr for ethylene, ethylene glycol.

SITTENFIELD & ASSOC, MARCUS 1411 Walnut St, Philadelphia 2, Pa; ph Rittenhouse 6-7861. Marcus Sittenfield, Pres. Affil, Alliance Construction Corp at above address.

Services—consulting chemical engrg, process design, plant engrg & design, economic surveys, air & stream pollution chemical processes, constr. Provides engrg, design & constr for alkyl aryl sulfonates, DDT, Epoxy resins, Esters, plasticizers, sulfonated alkyl benzenes, sulfur, synthetic detergents, synthetic resins; and engrg & design for acetic acid, alkyl aromatic detergents, alkylate — detergent, benzene hexachloride, butadiene, carbamate fungicides, carbon tetrachloride, chloral, chlorinated benzene, chlorohydrins, dichlorobenzene, ethanol, hydrogen sulfide, lindane, methanol, methyl chloride, propanol, solvents, sulfonates, wetting agents; and licensing, engrg & design for ethylene glycol & oxide.

SOUTHWESTERN ENGINEERING CO 4800 Santa Fe Ave, Los Angeles 58, Calif; ph LUdlow 3-6262.

Services—process design, mech engrg, constr, economic surveys & feasibility studies. Provides engrg, design & constr for alkylate —gasoline, aromatic & aliphatic solvents, hydrogen sulfide, naphthas.

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Services — consult, process design, mech engrg, constr, economic surveys.

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Services—licensing, advis, & process design in fields of alkylation, sulfonation, lube oil treating, grease manufacture, & design and supply of special liquid phase reaction equipment for petroleum & chemical industries. Provide licensing & engrg & design for alkylate (gasoline); and engrg & design for alkylate (detergent), dodecyl benzene, synthetic detergents, petroleum sulfonates.

SUMNER SOLLITT CO. 307 North Michigan Ave, Chicago, Illinois, ph State 2-4459, A. J. Barth, vice president. Subsids, Engrg Div, same address. Affils, Sumner Sollitt Co. of Texas and Sollitt Overseas Construction Co, same address as above.

Services—consulting, process design, economic reports, complete engineering and construction.

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Services—licensing, advis, consult, process design, mech engrg, constr, R&D, economic surveys etc. Provide engrg, design & constr for latex, methyl vinyl pyridine, petroleum resins, polybutadiene-acrylonitrile elast, polybutadiene-styrene elast, polyvinyl chloride, polyvinyl chloride resin, sulfur, hydrogen sulfide, synthetic rubbers; and engrg & design for butadiene, butylene-1, butylene-2, methanol, miticides, polyesters, styrene, triethylene glycol; and constr for acetylene, chlorinated solvents, vinyl chloride.

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Services—licensing of processes developed by either or both The Texas Company and Texaco Development Corp, independently, or in conjunction with others. Provide license for Texaco Synthesis Gas Generation process ($CO + H_2$)

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Services—process design, constr, consult, engrg.

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Thermodynamic Properties of Pure and Mixed Hydrocarbons

Part II—Latent Heats of Vaporization for Hydrocarbon Mixtures

By MERK HOBSON and JAMES H. WEBER
University of Nebraska

VAPORIZATION of a pure compound under equilibrium conditions takes place at constant temperature and pressure. In contrast to pure substances, however, the phase boundary for a mixture of given composition consists of a loop formed by the bubble-point curve representing the conditions for initial vaporization of the liquid phase and the dew-point curve representing the states for initial condensation of the vapor. Vaporization of a mixture, therefore, can proceed under a number of conditions of restraint, and it is possible to define several latent heats of vaporization for mixtures by specifying the manner in which the change of phase takes place.

The various vaporization processes for a mixture may be visualized by considering the vapor pressure relationships for the mixtures *A* and *B*, shown in Fig. 1. If heat is added to the liquid phase of mixture *A* at its bubble point, Point 1, the initial vapor formed will have composition *B*, the composition in equilibrium with the liquid phase. If the pressure is maintained constant as vaporization proceeds, the compositions of both the liquid and vapor phases become progressively richer in the less volatile components, and the temperature increases until vaporization is complete. The final temperature of the system is the dew point temperature of the original mixture. The process is illustrated by the path 1-2 in Fig. 1. The heat added during the process is equal to the change in enthalpy of the mixture between states 1 and 2, and this difference has been defined as the isobaric integral heat of vaporization. It is also possible to define an analogous vaporization process whereby the temperature of the system is kept constant while the pressure of the system is reduced to the dew point pressure as shown by path 1-3 on the diagram. The difference in enthalpy between the final and initial states is defined as the isothermal integral heat of vaporization. The overall effect in each of these processes has been to produce saturated vapor of the same composition as the original liquid, although in the first instance the restraint of constant pressure was imposed and in the second, constant temperature.

A third latent heat, the differential latent heat of vaporization, is also of interest in connection with mixtures. It may be defined as the heat required to vaporize unit mass of vapor under equilibrium conditions from an amount of liquid sufficiently large so that the composition of the liquid phase remains unchanged. The process takes place at constant temperature and pressure, point 1 on the diagram, and represents the formation of vapor *B* from a large amount of liquid *A*. Unlike the two integral heats, the differential latent heat of vaporization does not represent the difference in enthalpies between vapor and liquid phases directly.

Of these three latent heats of vaporization, only the isobaric integral heat is of direct value for process calculations. This type of vaporization is frequently met in problems involving complete vaporization or condensation of a mixture. The process engineer is normally interested in the enthalpies of the saturated phases for purposes such as an energy balance around a distillation plate rather than the latent heats themselves. The principal value of the latent heats defined above, therefore, is to provide an independent method for establishing the relative enthalpy of the saturated phases of mixtures. The problem of predicting the latent

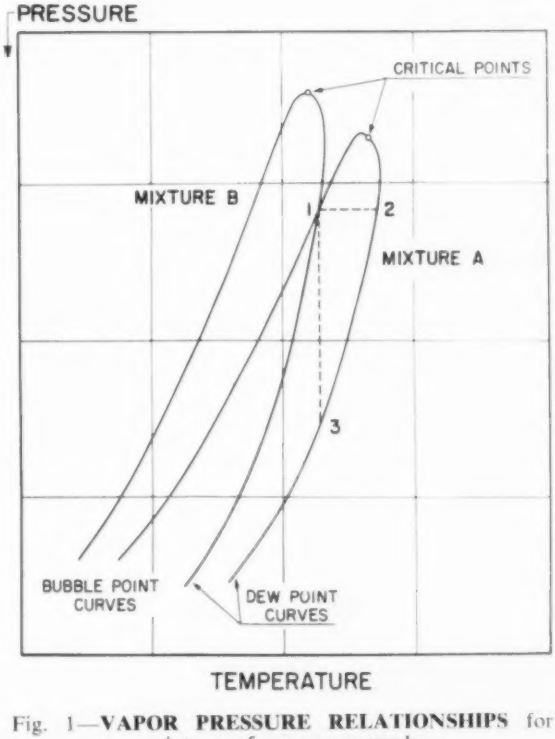

Fig. 1—**VAPOR PRESSURE RELATIONSHIPS** for mixtures of pure compounds

heats of vaporization for mixtures should be considered merely one aspect of the more general problem of predicting the enthalpy of mixtures under all conditions.

Rigorous methods

The relationships of thermodynamics make it possible to develop rigorous mathematical expressions for each of the latent heats previously defined. Unfortunately, these expressions become quite complex for multicomponent systems, and the data required for solution are not generally available. For process design purposes it is not feasible to attempt rigorous solutions except for special purposes. These relationships will be discussed briefly, however, because they demonstrate the type of experimental data that are required, and are helpful in evaluating the approximate methods that have been suggested.

Isothermal integral latent heat of vaporization

Bahlke and Kay[1] have used the relationship for the isothermal integral heat of vaporization in conjunction with experimental volumetric data for two light petroleum fractions to establish the enthalpy values of the saturated phases. Bloomer, Eakin, Ellington, and Gami[4] have also used this procedure in preparing the thermodynamic properties of methane—nitrogen mixtures.

In the case of the isothermal integral latent heat of vaporization, it is possible to integrate the general differential equation for a change in enthalpy over the actual path of the vaporization. The general expression:

$$dH = TdS + Vdp \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

can be applied to the isothermal process at constant composition. At constant temperature:

$$dS_T = \left(\frac{\Delta P}{\Delta T}\right)_v dV \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

and substituting Equation (2) in Equation (1):

$$dH_T = T\left(\frac{\Delta P}{\Delta T}\right)_v dV + Vdp \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Equation (3) may be integrated between the bubble point and dew point pressures for any mixture to obtain the isothermal integral heat of vaporization, ΔH_T.

Integration of the first term on the right side of the equation requires extensive P-V-T and equilibrium data for the two phase region. Values of $(\Delta P/\Delta T)_v$ are required as a function of volume. These may be determined graphically by first plotting the combined volumes of the equilibrium liquid-vapor mixtures produced in the isothermal expansion as a function of the pressure of the system. Because the compositions of both phases change throughout the expansion, volumetric and equilibrium data are required for all of these compositions as well as the original mixture. Once the P-V isotherms are established, however, it is possible to plot the P-T relationships at various constant specific volumes between the bubble point and dew point volumes. The slopes of the P-T curves may then be readily determined at each specific volume and at the temperature of the system. The second term can be determined by graphical integration of the appropriate P-V isotherm previously established. Although this procedure has been applied in the references cited above, it is not of practical value to the design engineer because of the large amount of P-V-T and vapor-liquid equilibrium data required over a wide range of compositions and the rather tedious graphical integrations that are involved.

Isobaric integral latent heat of vaporization

It is not practical to carry out a direct integration for the isobaric vaporization of mixtures as was done in the isothermal case. At constant pressure, the last term in Equation (1) is zero, and the remaining terms form an identity. It is possible to evaluate the isobaric integral latent heat of vaporization from the difference in enthalpies of the saturated phases. Dodge[8] presents the relationship for determining the isobaric integral heat for a binary mixture from the latent heats of the pure components, the heat capacities of the pure components and the integral heat of solution. Because there are relatively few heat of solution data available and since this method is more closely related to the general problem of estimating enthalpies of mixtures, it will not be discussed in detail.

Differential latent heat of vaporization

The differential latent heat of vaporization, however, does represent an independent means of obtaining enthalpy differences between phases under equilibrium conditions. It is related to the vapor pressure of the mixture by the Clapeyron equation in much the same

Nomenclature

H	=	enthalpy, Btu/lb mole
$\overline{H}$	=	partial molal enthalpy of component in solution, Btu/lb mole
$\overline{\Delta H}$	=	partial isobaric integral latent heat of vaporization, Btu/lb mole
ΔH_d	=	differential latent heat of vaporization, Btu/lb mole
ΔH_p	=	isobaric integral latent heat of vaporization, Btu/lb mole
ΔH_T	=	isothermal integral latent heat of vaporization, Btu/lb mole
K	=	distribution coefficient, y/x
P	=	absolute pressure, psia
R	=	gas law constant, 1.987 Btu/lb mole-°R
S	=	entropy, Btu/lb mole-°R
T	=	absolute temperature, °R
V	=	molal volume, cu ft/lb mole
$\overline{V}$	=	partial molal volume of component in solution cu ft/lb mole
x, y, z	=	mole fractions in the liquid phase, the vapor phase, and in either phase, respectively

Subscripts

g	refers to the vapor phase
l	refers to the liquid phase
P, V, T, N	refer to constant pressure, volume, temperature, and composition, respectively
$1, 2, 3, i$	refer to components in a mixture

Superscripts

o	refers to the property in the ideal gas state

way as for pure substances. Transfer of mass under equilibrium conditions takes place at constant temperature and pressure but between phases of different composition. Equation (2) may be applied to the transfer resulting in the Clapeyron equation:

$$\left(\frac{\Delta P}{\Delta T}\right)_N = \frac{\Delta H_d}{T\Delta V} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The first term in the equation represents the slope of the bubble point curve for a mixture of constant composition. The slope is independent of volume and the constant volume restriction in Equation (2) is meaningless under these conditions. The ΔV term may be interpreted as the difference between the molal volume of the vapor formed and the volume that the mass occupied in the liquid phase:

$$\Delta V = V_g - V_{lg} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The term V_{lg} differs from the molal volume of the liquid phase because of the change in the relative amounts of each component present in the liquid and vapor phases. This difference can be conveniently demonstrated in terms of the partial molal volumes of each component.

$$V_{lg} = y_1\overline{V}_1 + y_2\overline{V}_2 + y_3\overline{V}_3 + \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$V_l = x_1\overline{V}_1 + x_2\overline{V}_2 + x_3\overline{V}_3 + \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The difference is therefore:

$$V_{lg} - V_l = (y-x)_1\overline{V}_1 + (y-x)_2\overline{V}_2 + (y-x)_3\overline{V}_3 \quad \ldots\ldots (8)$$

Substituting for V_{lg} in Equation (5):

$$\Delta V = V_g - V_l - (y-x)_1\overline{V}_1 - (y-x)_2\overline{V}_2 - (y-x)_3\overline{V}_3 \quad \ldots (9)$$

For a binary mixture, only the first two partial volume terms need be considered, and because the mole fractions of one component can be expressed in terms of the other:

$$\Delta\overline{V}_1 - \overline{V}_2 = \left(\frac{\Delta V_l}{\Delta x}\right)_{T,P} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Equation (9) may be simplified to:

$$\Delta V = V_g - V_l - (y-x)\left(\frac{\Delta V_l}{\Delta x}\right)_{T,P} \quad \ldots\ldots\ldots (11)$$

The ΔH_d term is defined as the differential latent heat of vaporization, and can be related to the enthalpies of the saturated phases by equations parallel to those developed for the volume change. Thus:

$$\Delta H_d = H_g - H_l - (y-x)\left(\frac{\Delta H_l}{\Delta x}\right)_{T,P} \quad \ldots\ldots\ldots (12)$$

Rigorous application of Equations (4), (11), and (12) requires *P-V-T* data for the saturated phases, and partial volume and enthalpy data. The latter are most frequently unavailable, but the Benedict-Webb-Rubin equation of state[2] has proved quite useful in obtaining accurate volumetric data for binary mixtures from which the partial volumes and enthalpies may be determined, at least in the vapor phase. Stiehl, Hobson and Weber[18] have used this procedure to determine the differential latent heats of condensation for methane-ethane, ethane-butane, and propane-butane systems at elevated pressure. The condensation process was used rather than vaporization so that the *B-W-R* equation might be used to evaluate $(\Delta V/\Delta y)_{T,P}$ and $(\Delta H/\Delta y)_{T,P}$ in the vapor phase. The principal value of this procedure is in obtaining reliable values for saturated liquid enthalpies to serve as a standard of comparison for more general approximate methods.

Practical methods

From the foregoing discussion, it is apparent that the process engineer must depend upon generalized methods for a practical solution to the problem of estimating latent heats of vaporization for mixtures. In most instances, the equilibrium states represented by the bubble and dew points must be estimated using generalized correlations of the equilibrium distribution ratios.

In general, the thermodynamic properties of mixtures have been estimated by either a summation of the contributions of each component in the mixture or by considering the mixture equivalent to a hypothetical pure compound. Both of these procedures have been applied to the problem of estimating the latent heats of vaporization for mixtures. Some of the methods lead to direct estimates of the integral latent heats while others involve determinations of the enthalpies of the saturated phases and latent heats by difference.

Component contribution methods

In its simplest form, the component contribution method involves the assumption of an ideal solution in both the vapor and liquid phases. Under these restrictions, the contribution of a component is not affected by the nature of the other components in the solution. The properties of the mixture can be determined by a summation of the properties of the pure components in proportion to their mass in the mixture. This procedure is rigorous only for the ideal gas state. It is reasonably satisfactory for the gas phase up to moderate pressures, but it is not generally valid for the liquid phase even at low pressures.

Peters[15] has used the ideal solution concept in preparing a series of charts for estimating the enthalpy contributions of five of the light hydrocarbons in mixtures. The charts are based on the assumption that the partial enthalpy of the compound in mixtures is the same as the enthalpy of the pure material for the vapor phase above the critical temperature of the pure substance and for the liquid phase below the critical temperature. The partial enthalpy in liquid mixtures above the critical temperature and in vapor mixtures below the critical temperature were obtained by adding a partial isobaric latent heat of vaporization calculated by:

$$\ln\frac{K_2}{K_1} = \frac{\overline{\Delta H}}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right] \quad \ldots\ldots\ldots\ldots\ldots (13$$

where states 1 and 2 refer to the bubble and dew points, respectively, at the same pressure. This relationship may be derived for ideal solutions.

The relationships of thermodynamics may be rigorously extended to components in mixtures using partial molal extensive properties that are functions of composition as well as temperature and pressure. The major limitation in the practical application of this concept has been that the data required for determining the partial molal properties are essentially the same data that the engineer is interested in obtaining from their use. This limitation is not so serious, provided that additional parameters can be developed that will satisfactorily correlate partial properties as a function of the composition of the mixture. Average molecular weight, API gravity, and molal average boiling point have been used

for hydrocarbon mixtures with reasonable success.

The excellent results obtained through the use of the Benedict-Webb-Rubin[2] equation of state in predicting the volumetric data for binary hydrocarbon mixtures has developed some interest in the partial enthalpy approach, however. Edmister and Canjar[11] calculated partial enthalpy values for six light hydrocarbons using the fugacity coefficients originally developed by Benedict, Webb, and Rubin[3] from their equation. Papadopoulos, Pigford, and Friend[16] also presented partial enthalpy values for methane, ethane, and propane obtained by direct differentiation of the *B-W-R* equation. In both instances, partial enthalpy values for both the liquid and vapor phases were correlated using the molal average boiling point as the composition variable. Integral latent heats of vaporization may be determined from these values as the difference between the enthalpies of the saturated phases:

$$\Delta H_P = \sum (y_i H_i)_2 - \sum (x_i H_i)_1 \quad \ldots\ldots\ldots\ldots \quad (14)$$

The partial enthalpy correlations cited above yield reasonably precise results, particularly in the vapor phase, but the data available at the present time are limited to a relatively few hydrocarbons over a limited range of conditions. The uncertainties in this method are primarily caused by use of the *MABP* as the correlating parameter for mixtures and the use of the *B-W-R* equation of state at the high densities associated with the liquid phase.

Edmister[9] has proposed a method of evaluating the isobaric integral latent heat of vaporization based upon De Priester's[7] vapor-liquid equilibrium *K* values. In essence, the partial isobaric integral heats for each component are determined from the equilibrium distribution ratios, *K*, and the summation of the contributions of the components provides the integral heat of the mixture. Edmister's final equation is:

$$\Delta H_P = \sum Z \left[\frac{RT_1T_2}{T_2 - T_1} \ln \frac{K_2}{K_1} \right] + \sum Z \Delta H^\circ \quad \ldots\ldots \quad (15)$$

It will be noted that Equation (15) is Peter's relationship, Equation (13), with the exception of the summation term representing the difference between the ideal gas enthalpies at the dew point and the bubble point.

Table 5—Isobaric integral latent heats of vaporization by various methods

Methane-Ethane System

Isobaric Integral Latent Heat, Btu/lb

Composition, Mole Fr. C_1	S., H., and W., Ref. (18)	E., Ref. (9)	C. and P., Ref. (6)	P., Ref. (15)
200 psia				
0.2	199	192	207	202
0.5	245	210	238	222
0.7	247	218	242	219
400 psia				
0.2	171	156	152	171
0.5	217	178	196	192
0.7	220	178	200	189
600 psia				
0.2	125	138	95	144
0.5	172	131	138	163
0.7	175	136	—	161

Ethane-n-Butane System

Composition, Mole Fr. C_2	S., H., and W., Ref. (18)	E., Ref. (9)	C. and P., Ref. (6)	S. and J., Ref. (17)
200 psia				
0.2	155	160	162	161
0.5	191	194	188	187
0.7	195	185	188	192
400 psia				
0.2	129	119	123	124
0.5	173	147	150	158
0.7	176	121	156	162

Equivalent pure component methods

The equivalent pure component method for estimating the properties of mixtures has developed largely as the result of the use of Kay's pseudo-critical concept[12] in conjunction with the generalized methods based upon the theorem of corresponding states. The pseudo-critical properties for the mixture represent the critical properties of an equivalent pure compound that has the same isometrics as the mixture, and may be used to estimate the volumetric behavior of mixtures from pure compound generalizations. The concept cannot be used with any degree of reliability for the estimation of latent heats for mixtures, however, because of the differences in the critical behavior between mixtures and pure compounds. Edmister[10] has suggested that the isothermal integral heat of vaporization might be estimated for a given mixture by adding the latent heat of vaporization of an equivalent pure compound at the bubble point of the mixture and at low pressure to the difference between the isothermal pressure corrections at the bubble and dew point pressures. The isothermal integral latent heats at higher pressures would then be estimated by the Othmer[14] or Watson[19] methods using the cricondentherm temperature of the mixture as the basis for the reduced properties of the mixture. It seems probable that any method based on pure component latent heats would yield results that are too low for mixtures.

Both the average molecular weight and the molal average boiling point have been used to characterize mixtures as equivalent pure compounds. Scheibel and Jenny[17] used the average molecular weight as the mixture correlating variable in developing nomographs for the enthalpy of liquid and vapor light hydrocarbon mixtures. The nomographs provide a rapid method for estimating enthalpies of the saturated phases. The latent heats may be determined by difference. The method is based on data for pure compounds.

Recently, Canjar and Peterka[6] have suggested a method for determining the enthalpy of saturated hydrocarbon liquid and vapor mixtures relative to the ideal gas state as a function of pressure, temperature, and molal average boiling point. These correlations are based on enthalpy data for pure hydrocarbons and assume that the properties of the mixture are the same as a pure material with normal boiling point equal to the molal average boiling point of the mixture. The isobaric integral heat of vaporization may be conveniently evaluated as the difference between the enthalpies of the saturated phases.

Comparisons between methods

The methods that have been discussed in the preceding sections are difficult to evaluate because of the relatively few reliable data that might be used for comparison. Enthalpy data have been derived for a few binary

hydrocarbon systems for which experimental *P-V-T* relationships are available, but precise values for multicomponent systems are virtually non-existent. Undoubtedly, all of these methods yield results that are reasonably satisfactory for most process design purposes. There is increasing interest, however, in obtaining maximum accuracy in estimates of this kind, so comparisons of the results obtained from these methods are of general interest.

To demonstrate the relative consistency of these methods, the isobaric integral latent heats of vaporization were calculated for several methane-ethane and ethane-butane mixtures and compared with the results obtained by Stiehl, Hobson, and Weber[18]. The latter values were obtained from experimental *P-V-T* data[5][13] using the *B-W-R* equation of state and the thermodynamically rigorous expressions for the differential latent heat of condensation, and are considered accurate to within 3%. In all instances, experimental values of the bubble points, dew points, and equilibrium distribution ratios were used in these comparisons. The results are summarized in Table 5.

At the lower pressure, there is reasonably good agreement between all of the methods. The results obtained from the generalized methods are consistently lower than the values derived from experimental data. This was found to be true in the comparisons that Canjar and Peterka[6] made of their method. The Canjar and Peterka method agrees quite closely with the Scheibel and Jenny[17] nomograph. This is to be expected because both are based on data for pure compounds. Both methods are relatively simple to use and are generally more convenient than the contribution methods.

NOTE: The next installment in this series of articles, "Part III—Enthalpy and Entropy Data for Pure Hydrocarbons," will appear in the October, 1957, issue of *Chemical Engineering*, a McGraw-Hill publication. The concluding installment, "Part IV—Enthalpy and Entropy Data for Hydrocarbon Mixtures," will appear in the November, 1957, issue of *Chemical Engineering*.

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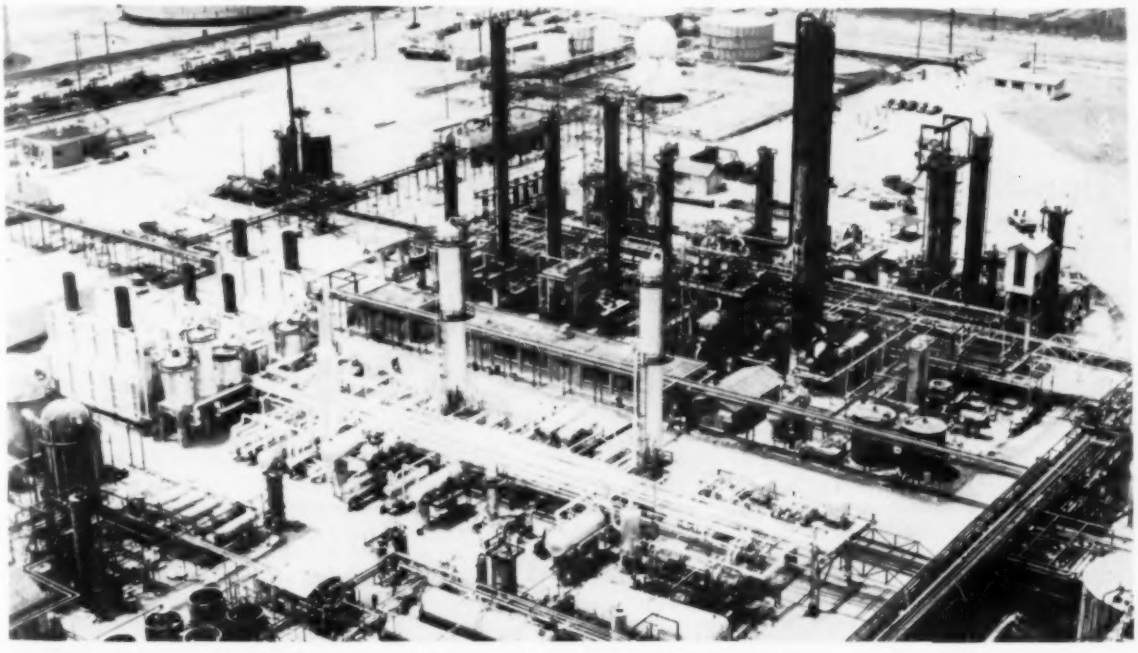
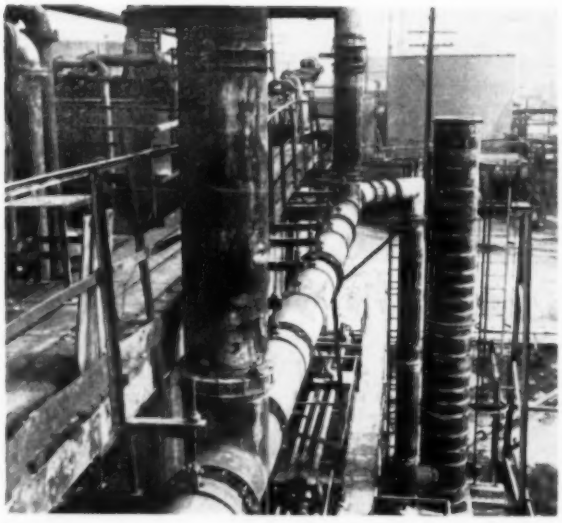
NEWS in VIEWS

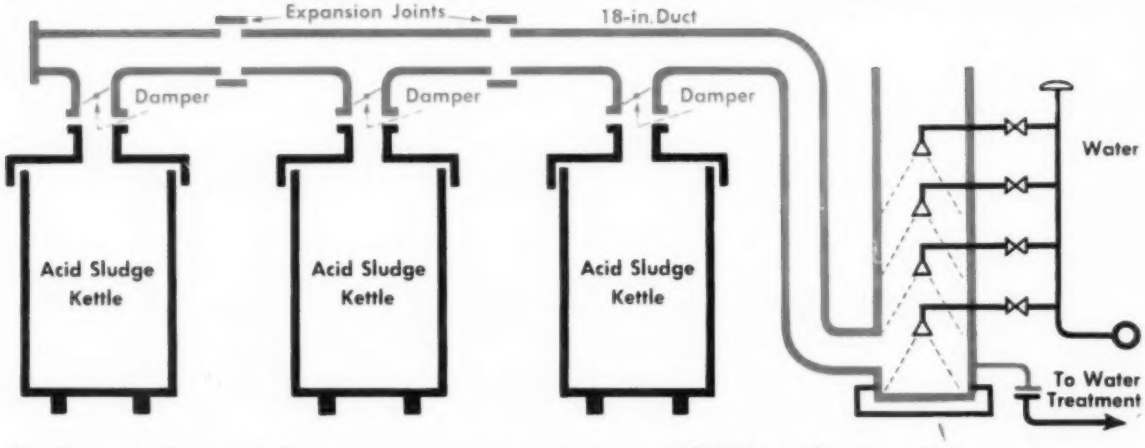


PROCESS AREA of Wilshire Oil's Norwalk, Calif., refinery now harbors an onstream, 10,000-b/d Unifiner-Platformer. The $3.5-million unit was designed and built by Southwestern Engineering under UOP license.



These plastic pipes carry . . .

Fumes from these tanks to...



Atlantic's acid recovery system, which shows how to . . .

Use Plastic for Acid Handling

The problem

AT ITS Philadelphia refinery, Atlantic Refining Co. operates a contact acid plant, producing 150,000 lb of sulfuric acid daily. Operating in conjunction with—and as part of its acid treating process—is the acid recovery system that supplies feed acid for the contact plant.

To recover acid in the refinery sludges, the acid-bearing material is put into three 2700-bbl metal tanks, each about 30 ft high and 30 ft in diameter. Acid is separated from the sludge by hydrolyzing. Live steam blown into the tanks separates the sludge material into four layers—recoverable oil on top, a flowing sludge next, sulphuric acid of 60 to 65% strength below this, and a solid sludge on the bottom. The oils and sludge are burned in the boiler plant. The

recovered acid is used as feed in the contact process for producing sulfuric acid.

During the hydrolyzing process in the tanks, the boil-off contains a high percentage of SO_2 gas. Unless contained and disposed of, this corrosive gas creates an air pollution problem and a health hazard; it has to be contained. Because of the high corrosive properties of SO_2, it was necessary to design a completely corrosion-proof vapor recovery system. This is where the proper application of a plastic rang the bell.

The solution

TO CONTAIN and recover the SO_2 fumes, the three tanks were covered, with a duct system from the top of each tank carrying the boil-off fumes to a scrubber. Here the SO_2 is absorbed by water sprays to form weak (5%) sulfurous and sulfuric acids, which are then fed into the acid disposal sewer system and neutralized at the water treatment plant.

Many different materials were examined before one was selected for the fume duct ones. Although lead had been used in similar installations for many years it was ruled out. Lead ducts need special bracing and support beacuse lead is really a lining material. Also, the danger of pin-hole leaks becomes serious in lead—even with the improved homogenized material—and limits severe temperature variations.

Acid kettles for hydrolyzing the refinery sludges have lead-lined steel covers. At the time the kettles were built, there was no satisfactory way to build a 30-ft-diameter unsupported cover. This problem has now been licked.

Because other Haveg material had been used successfully for applications within the refinery, it was restudied and selected. Atlantic had put plastic Haveg material through severe tests fifteen years previously and found that it could withstand more than its rated temperature, and that even short-time extreme temperatures did not damage the material—a distinct advantage for use in the fume duct.

Design considerations

The material finally selected for the fume duct and scrubbing tower was Haveg 41. In handling this material, which has five times the coefficient of expansion of the steel tanks to which it was mounted, expansion joints were required. It was also necessary to mount the entire plastic structure so that it had freedom of motion to use the expansion joints. Two expansion joints were placed in the fume header, between each of the three tanks, permitting any of the tanks to expand or contract separately. This was done because only one of the tanks might be steamed at a time.

Plastic 18-in. dampers were installed in the duct at the top of each tank, just before the tank outlets entered the common discharge header. Together, the damper and the expansion joints made the operation of any single tank practical, even though all tanks are connected by plastic pipe having a high coefficient of expansion.

The design of the entire fume duct required a uniform slope of about 0.19 ft in 100 ft to allow any condensate to run through the pipe. It was feared that condensate collecting around the cemented joints of the pipe and the expansion joints might cause corrosion if left standing. But this has not proved to be the case.

In mounting the plastic scrubbing tower, it was necessary to provide a strong base to: 1—prevent the tower from toppling when loaded, and, 2—to provide complete rigidity for connecting the water feed lines to the tower. It was also essential that any play in the fume duct, as it dropped to the bottom of the tower, would not crack open the plastic column. To prevent any mishap, the base of the tower was set into a slight depression in the concrete, providing sufficient rigidity to the tower base as well as the tower itself.

The spray tower, with an overall height of 29 ft, was fabricated in two sections, then bolted together in the field. Four spray nozzles of brass were uniformly distributed at six-foot intervals over the height of the tower, after considerable development work to assure full spray coverage of the tower. A spray angle of 60° (full included angle) was finally settled on as one that would not permit any ascending SO_2 fumes to escape to the atmosphere.

The four spray nozzles were brought into the tower through lead-lined, steel access doors, using brass fittings for protection against the fumes inside the tower. However, it is now felt that plastic pipe could have been used for the valve and flange, thereby eliminating the lead-lined steel with its expansion value different from that of the plastic tower.

The bottom of the tower is sloped to allow complete drainage through the plastic drain lines (again Haveg 41) to a terra-cotta trap and sewer line, which are connected to the refinery acid sewer system.

This design use of a plastic in a refinery has proved successful at Atlantic's Philadelphia refinery. There has been no evidence of any corrosion damage to the plastic equipment for more than two years of operation, although steel pipe in the same area is continually being replaced because of corrosion damage. Also, since installation of the plastic fume removal equipment on the acid sludge recovery tanks, there has been a noticeable slowdown in external corrosion of other equipment in the area—another plus benefit from the use of plastic.

What is Haveg 41?

Haveg is a general trade name for many types of plastic materials normally made of synthetic resins with chemically inert reinforcing agents. Haveg 41 is based on a composition of phenol-formaldehyde resin and an acid-digested asbestos fiber. It is strong and resists shocks, both physical and thermal, up to 300° F. It is resistant to most acids, salts, weak bases and many solvents—but it is not recommended for oxidizing agents or strong bases.

Most Haveg materials are used as the sole construction material in fabricating chemical-resistant vessels. It is not used only as a lining for large single pieces but can be molded without seams and requires no supporting shell.

What To Do With Spent Clay?

By GEORGE F. FELTON
Project Engineer
Sun Oil Co., Marcus Hook, Pa.

DISPOSAL of contact and percolation filter clay has been a problem for those refineries using it. It has usually required a dumping ground within easy hauling distance of the source unit, and finding some use for the dump after it has been filled to capacity with a conglomeration of processed clays.

But by productive development work at its Marcus Hook refinery, Sun Oil Co. has turned this processed clay into a valuable product. It can now be used by blending the processed clay with native clay for:

- Reclaiming swampy land for refinery use,
- Soil-bearing foundations,
- Storage tank foundations, and
- Water stop for dikes and levees.

Because "fill" has been a hoarded commodity at our Marcus Hook plant, the thought of using spent clays in reclaiming tideland area received first consideration. In the past, all clean, excess excavation remaining from the construction of new projects has been stockpiled and released as a requisitioned material. To use spent clay to supplement this hoard of valuable fill meant finding two things: a way to stabilize and consolidate the waste clay, and some way to attain a density that would not yield to normal compression or shearing stresses.

Test loads on areas where spent clays had been spread out for years and allowed to consolidate naturally, and on others where the clay had been compacted by traffic, showed that it had no potential as a structural bearing material in this condition.

Table 1—Fill Settlement in initial pit test

Test load lb/sq ft	Bottom settlement before fill, ft	Top settlement after fill ft
1000	0.011	0.004
2000	0.071	0.019
3000	0.237	0.026
4000	——	.033
5000	——	.040
6000	——	.043 (after 1-in. of rainfall)

But combining with silty or sandy soils looked like another possibility. The spent clays were individually combined with the native clay found in Marcus Hook, with various ratios of spent clay and different moisture contents. Tests in the soil testing laboratory—compression, shear, consolidation and permeability—showed that the blended clays had good possibilities.

Test cores made from a waxy spent clay and native clay gave a maximum loading of 4500 lb/sq ft, which was equivalent to a job load of 5600 lb/sq ft. Triaxial shear tests indicated a cohesive strength of 900 to 1100 lb/sq ft with a friction angle varying from 36 to 32° respectively. Permeability in a falling head permeameter test averaged 2×10^{-5}. Because there was no apparent leaching of oil or wax, the overall results suggested the use of the blended clay as an effective water stop for core walls on dikes or levees.

Encouraged by these lab results, a full-scale test was made in the field. To discover the best blending and compacting procedures, an experimental pit 30 ft wide x 100 ft long x 5 ft deep was dug and a test load

Here's How Sun Oil Co. Handles Its

ALL WASTE CLAYS at the Marcus Hook refinery are hauled to a 45-acre site being developed for manufacturing purposes. Native clay from 20 acres of this area which have a sedimentary formation not suited for soil bearing foundations, is blended with the spent clay. Blending is done by a dozer.

BLENDED CLAY is deposited daily as a stable, compacted fill on the 25 acres of tide land. Some 100 cu yd of the blended clay are taken daily from a 20-acre strip adjacent to the tide land, where spent clay has been blended with native clay. The depressed area pictured above is being raised 5 to 6 ft.

applied to the bottom of the pit to determine the structural character of the subsoil before back filling. The pit was back filled in 6 to 8-in. layers of compacted fill using a 10-ton bulldozer for both blending and compacting operations.

Satisfactory compaction was attained with an average of four passes of the Caterpillar tracks. A test load applied on the top of the 5-ft fill demonstrated that compounded fill was structurally superior to the original clay tested at the bottom of the pit. Settlement at the bottom of the pit with 300 lb/sq ft loading was 2⅞ in, while the top of the newly made fill settled only 5/16 in. Test results of incremental loads up to 5000 lb/sq ft (tabulated in Table 1) clearly demonstrated that the blended clay was capable of supporting 3000 to 4000 lb/sq ft.

The first practical use of the spent clay as stabilized fill material was made on a half-acre parking lot located on a swampy section of land that had insufficient bottom to support Caterpillar-drawn equipment. A dry compound of waxy clay and native clay was used to cover the first several feet of muck and to absorb the residual water. Densifying the bottom 18 in. of fill with the usual rolling equipment was difficult. Fast and effective results, however, were finally achieved by using a "TERRAPAC" or vibrating roller. Satisfactory densities were attained with two to three passes on an 18-in. lift. The finished parking lot with 3-ft average depth of fill showed no perceptible yield under a 20,000-lb wheel load. This surprising strength of the shallow fill indicated the unusual cohesive and bridging action of the compounded clays.

A second application of the blended clay as a stabilized fill has been the building foundations for oil storage tanks. Where the natural substructure consists of a fatty, unstable clay the addition of a granular percolation-type spent clay will improve the compaction characteristics. And where the substructure consists of a silty or sandy soil, the addition of a contact spent clay from either oil or wax processing will improve the cohesion characteristics.

In our efforts over the past 18 months, we have discovered the four mentioned uses for this previously troublesome waste. We hope that through continued efforts we will find other useful applications for waste clay, to the point where the problem will not be the disposal of waste clay but its production.

Meet the author

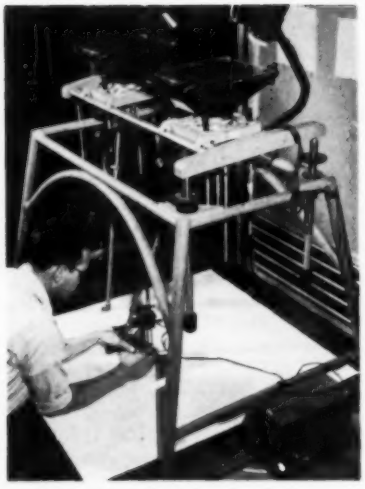
Mr. Felton

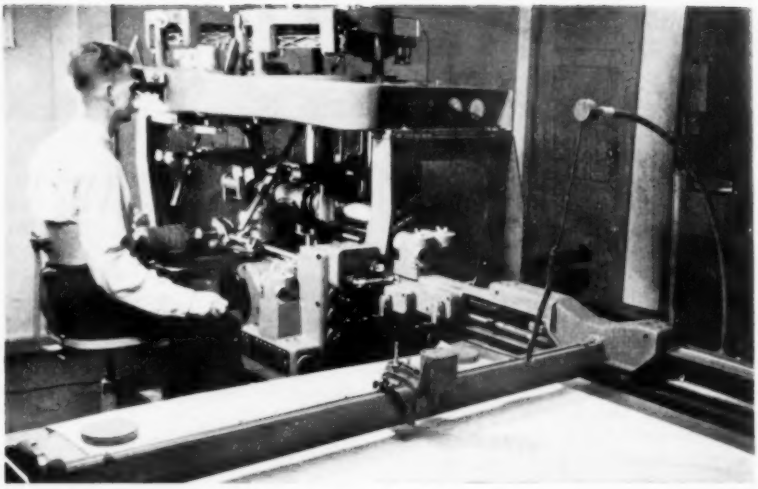
George F. Felton joined Sun Oil Co. in 1953 as a project engineer at the Marcus Hook, Pa., refinery. He had been working previously in a similar capacity with the Catalytic Construction Co. A native of Norristown, Pa., George Felton graduated from Pennsylvania State College in 1933 with a B.S. in civil engineering. He subsequently completed the advanced soil mechanics course at Drexel Institute of Technology in 1954.

Spent Clay

A VIBRATING ROLLER compacted the bottom 18 in. of fill used to convert a swampy section to a half-acre parking lot. With only one or two passes on a dry compound of waxy clay and native clay, this equipment obtained satisfactory densities. The finished lot, with an average fill of 3 ft, took 20,000 loads, showed no yield.

STORAGE-TANK FOUNDATIONS have been satisfactorily made with a blend of spent clay and native clay. A sub-base of 24 to 30 in. of well-compacted fill forms a tight, unyielding foundation. On the above 90-ft diameter, 48-ft high fuel-oil storage tank, about 2 ft of blended clay were compacted in 3 to 8-in. lifts.





CONTOUR MAPS are plotted on this American-made Kelsh stereoplotter (left) by projecting two aerial photos through colored filters. The operator wearing colored glasses can "see" depth and trace the contour lines. The $50,000 Wild plotter (right) maps more precisely. While the operator turns a handwheel, steering a dot of light, the plotter in the foreground draws contour lines. The Wild plotter is Swiss-made.

Air Mapping of Tidewater Site

. . . saved time and money

TIDEWATER'S new refinery near Delaware City had many firsts. One of the most unusual was the surveying of about half the 5000-acre site by airborne photographers. About seven square miles of land and the adjoining channel section of the Delaware River were contour-mapped from the air.

The aerial survey cost less than having the work done by a chain-and-transit crew moving on the ground—and was done in less time. It provided greater accuracy, particularly along the river shore, where the line at mean low tide was a base factor. In fact, it was about the only reasonable way to "freeze" the location of mean low tide, which occurs for only a few minutes once or twice a month. It would have been quite difficult for ground surveyors to even penetrate some of the ground necessary to do this job on the surface.

The aerial survey of the Tidewater refinery property below Wilmington, Del., was made by the Aero Service Corp., photogrammetric engineers of Philadelphia. In this kind of work the mapping team takes a series of aerial photos of the area, the photos overlapping much like the shingles on a roof. The amount of overlap is about 55% along the line of flight and 30% in adjacent lines. The plane travels 1000 ft or more between photos, the wide spacing heightening the stereoscopic or three-dimensional effect when the photos are studied in viewers or stereoplotters. All photos are taken at a controlled horizontal scale.

In the American-designed Kelsh stereoplotter used by Aero Service, the air photos in "stereo pairs" are positioned to reconstruct the altitude of the aircraft and camera when the photos were made. One photograph is projected through a blue filter, the other through a red filter, onto a round white plate or platen. The operator wears bi-color (red and green) viewing glasses. When he looks at the overlapping, red-and-green projected photos, he sees the land contours in a third dimension. The high parts seem to rise or "stand up" from the surface of the plate; the low parts, or valleys, fall away clearly.

The operator also sees a floating dot of light, which he can raise or lower so that it touches the peaks and valleys. He raises the dot to touch the highest point on the photo, then moves the plate to make the dot touch all points of this same elevation throughout the photo. As this is done, a pencil beneath the plate traces the contour lines on the map manuscript sheet. The same dot of light can be used to trace the outlines of buildings, roads, bridges and other structures. Once the aerial photos are taken, the preparation of the maps in the stereoplotters can go forward regardless of rain, snow or darkness, which, of course, limit the production of maps by ground surveying.

In the mapping project at Tidewater, a limited network of ground control, to establish exactly the vertical and horizontal distances, was obtained by field surveymen, using precise theodolites. These data were then related to the points in the air photos.

Aerial surveying is already being put to many services by industry. Used in connection with an electronic device, the airborne magnetometer, invented by Gulf Oil Corp.'s Research & Development Dept., this technique has supplied oil and mining companies with geophysical data which would have taken ground crews many years to develop. More lowly tasks of inventorying stock piles, log piles and open pit mines, and locating factory sites are also being done in the air.

Did you miss_____

. . . the complete technical story of Tidewater's new refinery? See the July issue of PETROLEUM PROCESSING for details.

WHEELER

McGREGOR

LOGWINUK

MADDOCKS

THORNTON

HAIG

FORTER

HARDCASTLE

BOCHOW

JONES

HOUSER

PETROLEUM PROCESSING tape recorded the last regional meeting of the Western Petroleum Refiners Ass'n in El Dorado, Ark. Here is the last in the series of technical tips on processing problems from the complete transcript (checked for accuracy by each speaker). Moderator of the panel of authorities that answered all questions was Harry K. Wheeler of Pan-Am Southern Corp., El Dorado, Ark. Members of the panel were: D. W. McGregor, Lummus Co.; Dr. A. K. Logwinuk, Houdry Process Corp.; R. R. Haig, Esso Research and Engineering Co.; A. A. Forter, Cities Service Refining Corp.; C. A. Hardcastle, Lion Oil Co.; Carl E. Bochow, Suntide Refining Co.; Bruce Jones, McMurrey Refining Co.; Mark E. Houser, Republic Oil Refining Co.; R. R. Maddocks, Blaw-Knox Co.; and D. P. Thornton, Jr., Universal Oil Products Co.

This month's technical tips on . . .

Treating and Other Problems

Wheeler: We have two questions grouped here on treating. Bob Maddocks, can you handle them?

? Distillation temperature limit: What is the upper temperature limit that can be used in distillation without thermal decomposition of mercaptans and disulfides?

Mr. Maddocks

Maddocks: Mr. Kalichevsky, whom we all know, has done work on distillation of naphthas after doctor treating. In one of his discussions on the subject he points out that there are actually two important considerations. They are temperature, which is pointed out here, and also time. He suggests that distillation after treating be done under a vacuum, and he points out that the temperature should not exceed 270°F. Preferably it should be held around 250°F.

? Sulfur removal in Girbotol operations: Does anyone have data on the relative merits of using monoethanolamine and diethanolamine in the Girbotol operation to remove sulfur compounds from light hydrocarbon streams?

Maddocks: From data on the relative absorption characteristics of DEA compared to MEA, it is apparent that MEA has the ability to absorb about twice the amount of H_2S that DEA can. However, one disadvantage of using MEA is its higher vapor pressure. Where you might be treating very high volumes of gas, the problem of loss of solution arises and becomes more important when you use MEA rather than DEA.

Mr. Haig

Haig: It's been our experience that as long as the only sulfur compound present is H_2S, MEA is obviously better. But it's also more susceptible to forming stable compounds and complexes with other sulfur molecules, such as carbonyl sulfide and some organic acids. The choice is always determined by economics. If you have nothing but H_2S in your gas, MEA is going to be cheaper. If you've got a mixture of sulfur compounds, DEA may turn out cheaper in the long run because of solution losses with MEA.

Maddocks: One other thing. If you're scrubbing a gas, such as flu gas, it's almost mandatory that you use MEA because it is the only amine solution that will resist oxidation.

? Removing salts from Girbotol DEA streams: Has anyone devised a simple method of removing high concentrations of heat-stable thiocyanate salts in the Girbotol DEA streams?

Mr. Forter

Forter: We tried a very crude experiment. Though I'm not familiar with all the facts, we did add some soda. It formed soluble salts that helped our unit.

Maddocks: I'd guess that the best way to separate this material would be by redistillation under vacuum.

Wheeler: I think somebody goes around and does that. He's got a rig and his services are available.

Mr. Wheeler

Eppard (D-X Sunray): The conventional method in gasoline plants with large amine units is to regenerate the MEA solution in a separate vessel. A batch of MEA is drawn off to the regeneration vessel. Soda ash is then added and the MEA steam distilled.

Wheeler: Are there any other questions on treating? Apparently treating isn't too much of a problem these days.

Downer (The Refining Engineer): I wanted to add something on the questions raised about cracking of mercaptans and disulfides. Kalichevsky set 275° as the point at which you would get some regeneration. At Esso's Baltimore refinery, when they were Sodafining heavy catalytic naphtha, there was considerable trouble with the back end of that material. They had to rerun it and take a 400° end point instead of a 430° end point. At those conditions, they did not get appreciable regeneration of mercaptans from the disulfides.

Dana (Atlantic Refining Company): On this point—disulfides breaking down to mercaptans—I think Mr. Kalichevsky is pretty correct. But you have to worry about the degree of disulfide breakdown. Certainly, if you're worrying simply about the doctor test, you don't have much trouble if you keep the temperature down under 300°. On the other hand, in the production of solvent naphthas, where you're worrying about an odor problem, we have had troubles at as low as 250°. Odor problems in the production of solvents are becoming more and more critical, so we have to be pretty careful.

Wheeler: Are there any more questions or comments on treating? We inadvertently left out one question. Nobody on the panel knows about this, but maybe you've got some experience. One of the questions was—

? Range oil: Has anyone had any experience with the copper sweetening of range oil?

Haig: We haven't had any in the domestic circuit—overseas, though, we have. We found that on an extracted kerosine, copper sweetening works all right. If it's not extracted, you just can't make it work. I don't think that extraction is used very much in this country. Overseas, quite a few places are making an illuminating kerosine that has to be fairly highly treated. So the answer won't help anybody much—but for some reason or another, an extracted stock can be copper sweetened successfully.

? Mixers for small tank blending: Has anyone had mixing difficulties when blending motor or aviation components (36° API to 73° API) in small 10,000 or 12,000 bbl tanks with mechanical mixers? What was done to remedy the trouble? If no trouble was encountered, what was the mixer design, i.e., tank dimensions, filling line size and number, mixer height and angle?

Wheeler: I'm the only one on the panel who has had experience with that, so I'll get into the act here for just a minute. We did have difficulty in a small tank. The trouble was the dimensions of the tank—a 10,000 bbl tank, small in diameter but extremely high, something like 44 or 48 ft. In using the rule of thumb of one horsepower per about 1,000 bbl, we had a 10 hp mixer in there. It didn't do anything. We worked with the mixing people for some time and they finally said that the dimensions of that tank were just wrong. It wouldn't mix because the tank was built wrong. We took the mixer out and put it in a conventional tank, about 37 or 38 ft high, and it worked fine. And we put a 15 hp mixer in the high tank. It has worked very well. But, I think the only problem we had at all was that the mixer was underhorsepowered for the dimensions of the tank.

Comment: What was the tank diameter?

Wheeler: As I recall, the tanks are 43 ft in diameter by 40 ft high.

Fiske (Leonard Refineries): We have two 10,000 bbl gasoline blending tanks equipped with mechanical mixers. Periodically we have had trouble getting these tanks properly mixed. This happens whenever there are more than five or six inches of water in the bottom of the tank. The trouble stops after the tanks are cleaned.

Wheeler: Do you have platforms in those tanks?

Fiske: No.

Wheeler: I think the mixing equipment companies are recommending that we put a platform under the impeller of the mixer when installing them. I think it's something like 6 ft by 12 ft, about 8 or 10 inches off the bottom of the tank, for exactly the reason you're talking about—so that you don't start mixing up the BS&W on the bottom of the tank.

Fiske: Sounds like a good idea.

Wheeler: Has anyone tried jet mixers:

Bercier (Cities Service Refining Corp.): We have—we save a lot of time. We've tried jet mixers in one of our small 12.5 tanks and we cut the time down about 12 hours. But it still takes from 10 to 12 hours to do a pretty good mixing job. By the way, we designed our own jet mixers.

? Portable cleaning equipment: Is anyone using portable cleaning equipment on reboilers and condensers? What has been his experience particularly with obtaining effective cleaning in the stagnant areas of shell and tube units?

Hardcastle (Lion Oil Company): We've built, in our shop, a portable rig for cleaning heat exchange equipment. It's essentially a rectangular vessel divided into six compartments with a total volume of about 1500 gal. We designed it with compartments so that it would take care of different sized heat exchangers and reboilers without excessive use of chemicals. The pump and whole assembly is mounted on a rubber-tired trailer, and we have the pump manifolded to circulate in one direction and reverse for reverse flushing. The unit is tied to the exchanger with flexible hoses for quick connection. We have a heater coil in the bottom of the vessel to provide heat for better cleaning. Of course, our experience to date has been somewhat limited—we're just getting into this—but we feel that we have been able to accomplish

cleaning in the order of 65% to 75% on the shell side. It's a little higher than that on the tube side. We haven't been able to eliminate pulling of the bundles but we have softened our residue deposits so we can clean them off easily with a high pressure rinse.

We feel that by some design changes, such as vent ports to eliminate air pockets, and possibly using a larger pump to get a greater circulation rate, we can raise this percentage up to about 90 or 95%. I might mention that we have had better success with towers. On the last turnaround of our No. 1 vacuum unit, we circulated chemicals through the vacuum tower—we have trays with 1622 bubble caps, which are pretty difficult to clean mechanically—and we feel that we got about 90% effective cleaning on the trays. We've decided to chemically-clean the vacuum tower on an annual basis. Anybody who would like to pursue this problem a little further should refer to an article in the *Oil & Gas Journal*, dated December 19, 1955, titled "Chemical Cleaning is Cheaper."

Mr. Bochow

Bochow: We've been using chemical cleaning at Suntide for about two years. In fact, I don't believe we have ever cleaned a tower mechanically. We started in somewhat the same way. We made several vats and mounted them on skids so that they could be moved from one spot to another. On location, thy're mounted on cribbings to make the necessary suction head available. We use the pumps in the unit—a reflux pump, for example—to clean a tower. We circulate through the tower. And on towers that have side draws, we clean the strippers along with the rest of the tower. We have also cleaned the slurry system on the cat cracker in the same way.

We clean our water system by acidizing. We bought a special pump to handle the acid and make a portable turbine-driven rig mounted on a trailer. We make all of our connections by flexible hose and always circulate in a direction reverse to the normal water flow. In this way, all the soil is removed and returns to the vat. We have found that on opening the exchangers we sometimes have an inch or two of a very soft deposit on the baffles separating the passes. This washes out easily with a fire hose, leaving the exchangers in perfect condition. The only trouble we've ever had has been with cleaning on the water side of exchangers that have been plugged, where we have had to get a circulation of the acid through the tubes to do any cleaning.

Here is an interesting example—we brought our crude unit down a few days ago for a revamp and we completely cleaned the water side of all the equipment. We gas-freed and cleaned all the towers and all of our hydrocarbon lines (almost every line in the unit had to be hydrocarbon-free before we could work) and we did this in somewhat less than 20 hours.

Wheeler: Anyone else want to talk about chemical cleaning?

Jones: I might mention one other matter. We have had similar experience, and have built our own portable chemical cleaning equipment. I might add that on sieve-type trays, (such as in our alkylation unit) we've had good success in chemical-cleaning them with a mixture of Oakite No. 88 and No. 8. We've had good success with that mixture, approximately a 50-50 mix.

Forter: I'd like to know the diameter of that crude tower at Suntide?

Wheeler: That's the vacuum tower, isn't it, Carl?

Bochow: Well, we cleaned all of them. Our atmospheric tower has about a 12-ft diameter. This tower was perfectly clean. It works well and is very fast. As I say, we appreciate that we can gas-free a tower in such a short period so that we can do our welding and get men in the tower quickly without doing a lot of steaming, etc.

? Automatic logging: Is anyone in the group using automatic logging equipment on operating units, and if so would he install such equipment again?

Haig: Well, the answer to the first part of that question is, yes. Esso Standard, in its Bayway refinery has automatic logging equipment on a UOP polymerization unit.

Would we install such equipment again? I don't know how well they've done on that equipment, but they are going ahead and putting in another automatic logger on a cat cracker down at Baton Rouge, so I assume they're satisfied with their first installation. As I understand it, the problem they're working on now is how to speed up the bicycle that the boy uses to carry samples to the lab. That's the slowest part of the operation now.

? Air recycling in cooling towers: By what means can air recycling be controlled on forced-draft cooling towers when the wind is from the back of the tower?

Bochow: I don't know if I can add much. We had quite an air recirculation problem on one of our cooling towers and we finally talked the manufacturer into adding an additional 12 ft on the stacks. We originally had 4-ft stacks and we added an additional 12 ft, making 16 ft overall. The results were easily seen on a humid morning. We could see that the amount of recycling of air was greatly reduced. Here is an interesting side effect—we found out that the load on all of our fans —it's an induced-draft tower—went down appreciably. We developed a natural draft because of the stack height. We were able to change the pitch on our fan blades and load the fans more, which resulted in actually contacting more pounds of air per pound of water. We did not notice an appreciable difference in the water temperature on the tower. However, we feel we are getting better efficiency from the tower.

? Continuous vapor pressure tests: What has been the experience, if any, on continuous vapor pressure tests on blending gasoline?

Wheeler: We struck out. There's nobody on the panel doing that. Is there anybody in the audience running continuous vapor pressure tests on gasoline who can tell us how it works out?

Mardaga: My data is about a year old, but we were planning to install a continuous unit—two of them, in fact—at our plant. We got some information from a company that had bought several of these units and had tested them quite extensively. They concluded that

the possible error in the type of unit available at that time—this was about a year ago—was great enough so that they were better off just taking a few more samples and running them in the lab. In other words, basically, it's a good idea. And when the tests can be developed to where you can rely on them down within a couple of tenths, then you're all right. I think the margin of error was either eight tenths to a full pound in the units available at that time.

? Butterfly valve seat rings: In the use of butterfly-type flare valves for catalytic cracking units, has a suitable seat ring been developed for positive shutoff when the system has been exposed to aromatic hydrocarbon, as well as 250°F steam?

Houser: We had difficulty in finding a suitable seal for our butterfly-type flare valves. We finally went to a butterfly valve with lubricated steel seats. In other words, a lubricant is pressed into the valve body and is deposited through channels onto the sealing surfaces. Now, whether this particular lubricant that we're using would be suitable for aromatic hydrocarbon or 250° steam, I do not know. Our practice is to give the valve a small shot of grease after each opening. We've had very good luck with this equipment.

? Fouling of feed preheat exchangers: How can this problem be solved in a (a) poly plant, (b) fluid cat crackers, (c) catalytic reformers. Is the mechanism of fouling the same in all these cases?

Wheeler: On the poly plant, Mark Houser, how about telling us what you have done at Republic, along these lines.

Mr. Houser

Houser: You might like to profit by an unsuccessful experiment that we carried out in our plant. A few years ago we decided to economize and use a partially spent caustic in our poly feed hydrogen sulfide scrubber. This caustic contained a small amount of acid oils. We fouled up the poly field heater in short order, shut down and cleaned it out. Within 48 hours it fouled up again. Since going back to fresh caustic, we've operated for a year with no trouble.

Wheeler: Does anybody else have any comments on poly plant heaters?

Forter: Speaking of that cat cracker feed preheater, we have a little operating gadget, as we call it, in the second stage of the chain where the temperature is entering at 400°—or a little higher. In the feed preheater exchange on these cat crackers, the second stage has a temperature of feed entering around 400 or 450°. In there we get some fouling, but what we have done to temporarily help things out from that point on to the highest temperature feed preheater, is to introduce steam and "jelly it up," as we call it. We don't know the mechanism of what occurs in there, but with a 30-minute jellying up, you can pick up some 20 to 50° on your preheat. But first, we thought perhaps on the slurry exchange we had some catalysts settling out and that this was helping to remove the catalyst, but the same thing happens in the other exchange. However, your bundles will kind of dance around on you. You'd better be careful how much steam you put in.

Hicks (Atlantic Refining): Was that steam you put in on the fresh feed side?

Forter: Yes.

Wheeler: Anybody else have any experience—Bruce Jones?

Jones: This was at another plant, but we had a problem, which sounds quite similar to the one Al just described. It was on the fresh feed side of our slurry to fresh feed exchangers. We gas blanketed the gas oil or fresh feed storage tanks, but this didn't completely eliminate the problem—although it apparently did give us a little longer onstream time. Finally, after some experimentation, we went to the use of a kerosine wash. We had three exchangers, which could be operated in parallel, and we could block one of them off and circulate kerosine for a few hours through the fresh feed side. We would clean the unit enough so that it would be comparable to a clean unit for a while. It would permit operation of the unit for 12 months or more, until turnaround time would permit a thorough mechanical job.

Wheeler: Anybody else have any ideas on feed preheater fouling? What about cat reformers?

Thornton (Lion Oil Company): How long did your heat transfer coefficient stay up after you washed it with kerosine—did it go down fast after that?

Jones: I would like to ask Bob Price to answer that question.

Price (American Petrofina): Well, we get about a month, now, before we wash again.

Wheeler: After it once gets bad, and you clean it, does it last about a month before you have to do it again?

Price: It's usually a matter of pressure drop with us, at least at the present time.

Jones: Was the kerosine put into the slop system and later recovered?

Price: No, we just circulate it.

Wheeler: Are there some answers here on cat reformers?

Logwinuk: Our problem is on cat reformer feed-effluent exchangers, and seems to be caused by oxygen in the feed. A solution to the problem is to go directly from the crude unit to a gas-blanketed, or floating-roof type intermediate storage. Another possibility may be a high heat flux in the exchanger that might bear watching.

Eppard: We have had experience with two of these problems: 1—fouling of feed exchangers on our FCCU, and 2—fouling of the feed exchangers on our Platformer. The first problem was solved by stripping the gas oil charge with natural gas. This has practically eliminated

the fouling on our feed exchangers. We have an exchanger on our gas oil charge heating the oil to 200°F before our stripper, but we do not have any foulings on this exchanger.

Our Platformer feed exchangers coked up once and we gas blanketed the charge tanks. This solved the problem.

Comment: Do you have any cracked stock when you use the oxygen stripper, or was it all virgin?

Eppard: The raw charge that is being stripped is a mixture of coker gas oil and virgin gas oil. The coker gas oil runs from 30% to 60% of this stream.

White (International Refineries): We had some experience with a reformer that had a floating-roof tank for the feedstock, but no feed stripper before the reactor. The vapor side of the feed exchangers was fouling rapidly. In fact, we couldn't get more than about a 5 or 6 weeks' run before we were shut down. The trouble turned out to be that we were operating the feed pump with a vacuum on the suction side, which pulled air into the reformer charge through the pump packing. We found that if we kept the level in our feed tanks high enough to keep about one pound positive pressure at the suction, we eliminated the problem.

Wheeler: In other words, your pump ran under a vacuum?

White: Yes, in fact, when the tank was low, it ran under quite a vacuum. I don't recall just what it was, but it was well below atmospheric pressure at the pump suction, when the feed tank was low.

Wheeler: That's all you've done to solve the problem: put a little pressure on the line?

White: Yes. The main problem was that the suction line of the pump was too long for the quantity of feed that we were pumping, and, therefore, there was too much pressure drop through the line.

Wheeler: That's an interesting discovery and might help other refiners.

White: Well, that solved the problem. To go back for a moment to cleaning exchangers with kerosine—we had a very bad situation caused by fouling of the crude side of some of the exchangers in our crude preheat circuit. We used a light gas-oil wash about once every two weeks and we found that by doing it regularly we could run for 18 months without excessive pressure buildup in the system. And the transfer rate held up fairly well. It took about four hours to wash through the system.

Forter: Do you have a desalter?

White: No, no desalter, but the crude was quite clean.

Wheeler: Any other comments on preheater fouling?

Killen: I heard that Atlantic was solving its problem with about 100 cu ft per tank of nitrogen gas-blanketing on floating-roof tanks—I wonder if the boys from Atlantic would comment on that?

Dana (Atlantic Refining): That quantity agrees with our experience. We are using it out of cylinders on two floating-roof tanks. Actually, the operation has been extremely successful in cutting down on the fouling problems in our preheat exchangers.

Comment: Do you have a cracked stock?

Dana: In that particular reformer, there's no cracked stock. It's a high sulfur feed and the problem was probably a combination of oxygen and sulfur. Now we've got the oxygen out of there. We also had an interesting problem similar to International's experience. We were running a crude running unit where the top of the tower was under a slight vacuum. We were sucking air into the system and getting a fouling problem in the preheat exchangers.

? Recycling aromatic streams: Has recycling of highly aromatic streams (60% to 90% aromatics) through furnaces with coil outlet temperatures of 900°F been attempted? Were any adverse effects observed?

Mr. Logwinuk

Logwinuk: At the Sarom Refinery in Ravenna, Italy, we have a thermal iso-plus unit in which the catalytic reformate is passed directly through a thermal reformer. The aromatics concentration in the charge to the thermal reformer is about 57.5% up to about 60%. The highest temperature it reaches is in the range of 1000 to 1100°F. They are reforming the catalytic reformate charge from 84 to 102 F-1 clear octane in that operation, and so far they have not run into any difficulties as a result of having aromatics at these high temperatures.

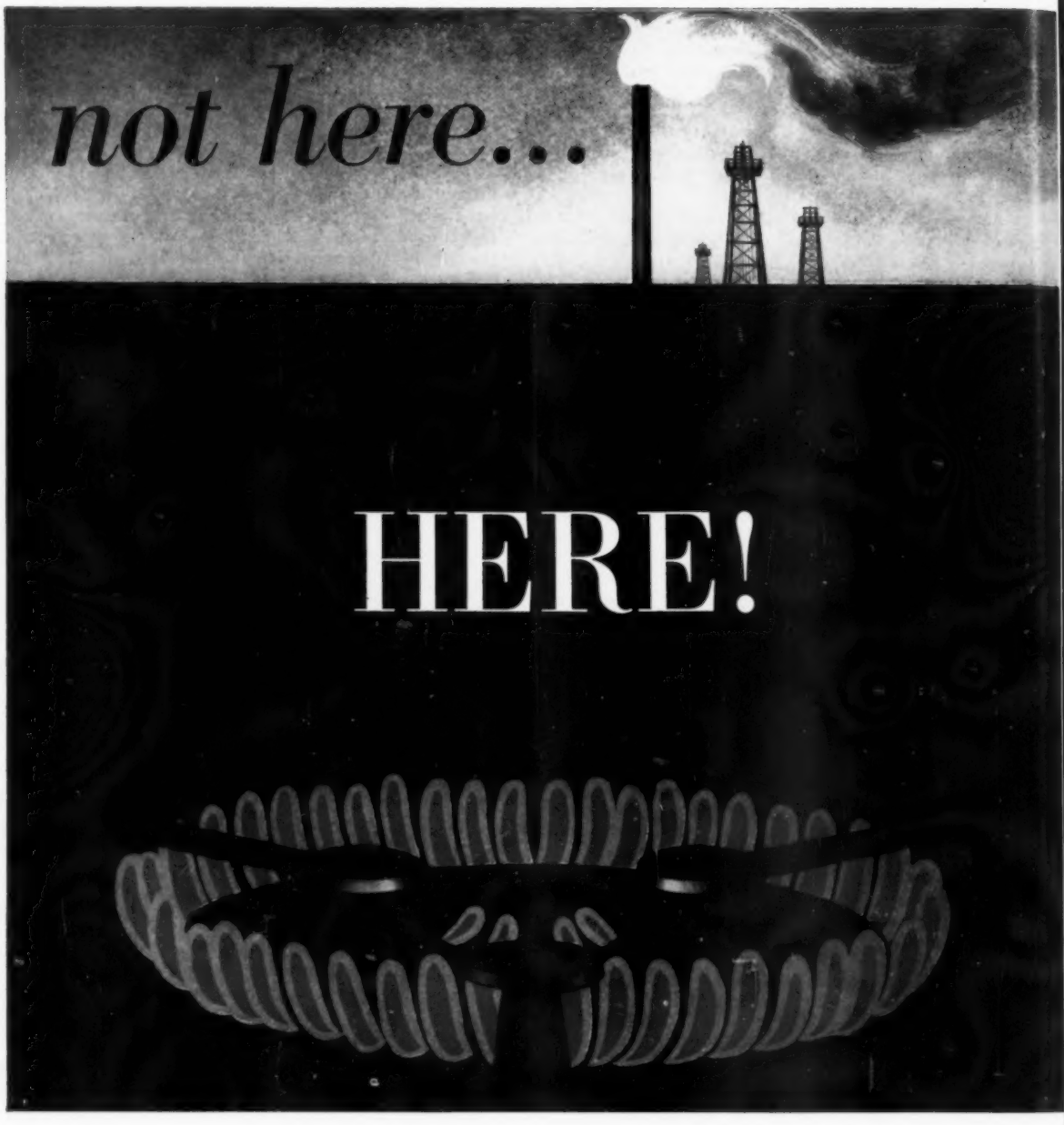
Mr. Jones

Jones: It might be of interest to know that we ran a heavy Platformate—a material that has about a 380° initial, and about a 580° end point—to our catalytic cracking unit. We took it out fairly quickly, because we became convinced that it promoted carbon laydown on the catalyst.

? Maintenance costs: Has anyone developed a good "yardstick" for evaluating maintenance costs?

? 100 octane: How are you going to make 100 octane gasoline?

Wheeler: We decided the first was a symposium and if we wanted to talk about maintenance costs and how to evaluate them, we ought to come back again next year. So, we're going to skip that one today. It's a good problem, but we don't have enough time to cover it. And that last one's a pretty good one, too. Just how are you going to make 100-octane gasoline? We aren't going to spend the rest of the afternoon talking about that. We have a suggestion—if all you gentlemen will come back next year, we'll tell you how we *did* make our 100-octane gasoline.



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Departments

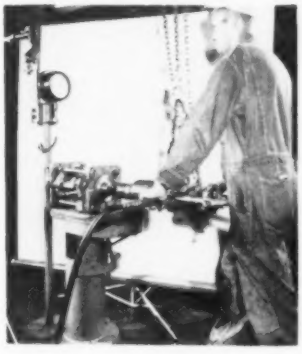
Keep Your Data File Up-to-Date

"Clip-n-File" process data Granular Ammonium Nitrate by the Stengel-C&I Process

The 22nd in our series of fold-out flowsheets describes Commercial Solvents' single-step process for ammonium nitrate manufacture. For flowsheet and text turn to **p. 173**

"Clip-n-File" engineering data Wall thickness— Unfired pressure vessels

Another short cut you can use in your unfired pressure vessel problems. Two tables make it easy for you to determine proper pressure vessel shell thickness. EDS No. 21 on **p. 193**



Jig makes life easier

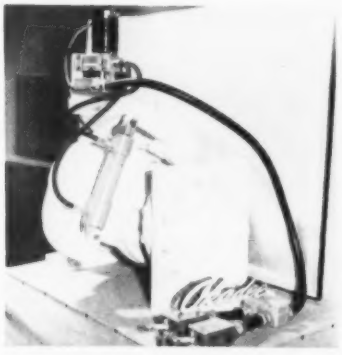
Impact tools are tested under simulated field conditions in this home-made rack at Union's Wilmington, Calif., refinery. Another Union-made timesaver is described in Plant Practices. **p. 177**

Cruse blows his fuse

It had to happen sometime. Cruse, like everyone else, has his limit. He reached it the day his old and unwanted generators got out of phase. For the whole surprising story, turn to the Bull Pen on **p. 183**

"When ended is the page. . ."

So wrote poet Masefield, who couldn't know PETROLEUM PROCESSING, but whose words nevertheless fit this reminder to turn to our last Editorial. It appears on **p. 256**



Small control runs big valves

This electro-hydraulic, remote-control unit fits into the space used by a wheel-operated valve. Among its features is a slow opening and closing time. Details of the compact unit are described in What's New on **p. 225**

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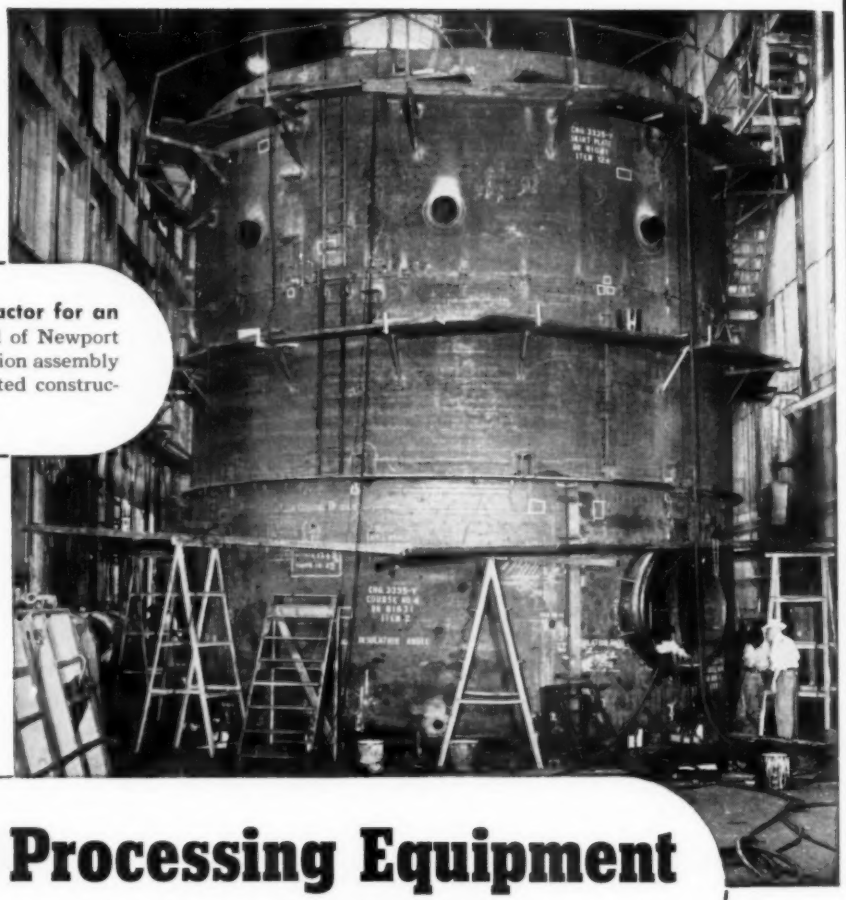

Course number four of a reactor for an overseas oil refinery. Typical of Newport News plant methods, the precision assembly of this unit in the shop expedited construction of the reactor in the field.

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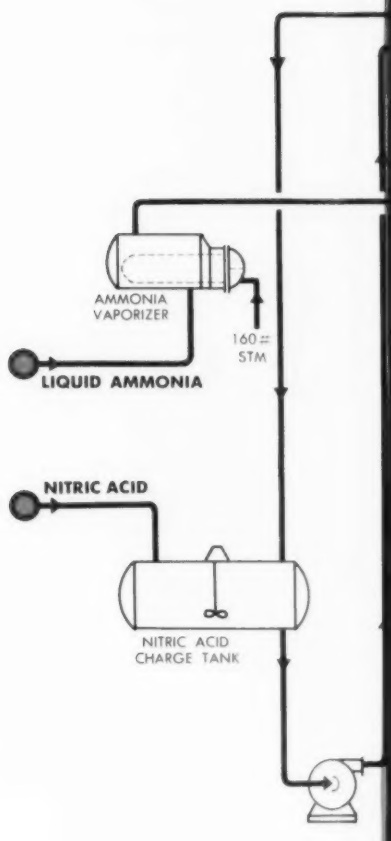


START HERE

Process—Single-step manufacture of ammonium nitrate containing any desired water content by the reaction of anhydrous ammonia vapor and 58% (approximate) nitric acid in a Stengel (Commercial Solvents Corp.) reactor.

Process Chemistry—Ammonia vapor and nitric acid react to form ammonium nitrate in the reaction:

$$NH_3 + HNO_3 \rightarrow NH_4NO_3 + 26{,}000 \text{ cal.}$$

A very slight excess of ammonia is used, and at normal operating conditions, equilibrium is such that the exit gases from the reactor contain comparatively small amounts of ammonia and acid vapors.

Process Description—Ammonia vapor and nitric acid (about 58% concentration) are preheated separately in specially designed heat exchangers and fed continuously and simultaneously into the Stengel reactor.

The reaction is exothermic, and very rapid, forming ammonium nitrate. The heat of reaction is sufficient to vaporize the water contained in the nitric acid solution feed. Flow from the reactor consists of ammonium nitrate, steam, and a trace of ammonia—all being discharged into the separator.

The centrifugal portion of the separator collects most of the molten ammonium nitrate, which flows into the air stripper. The stripper air is blown through the molten salt and up through the separator, carrying off water vapor and reducing the moisture content of the molten ammonium nitrate from 2% to about 0.2%.

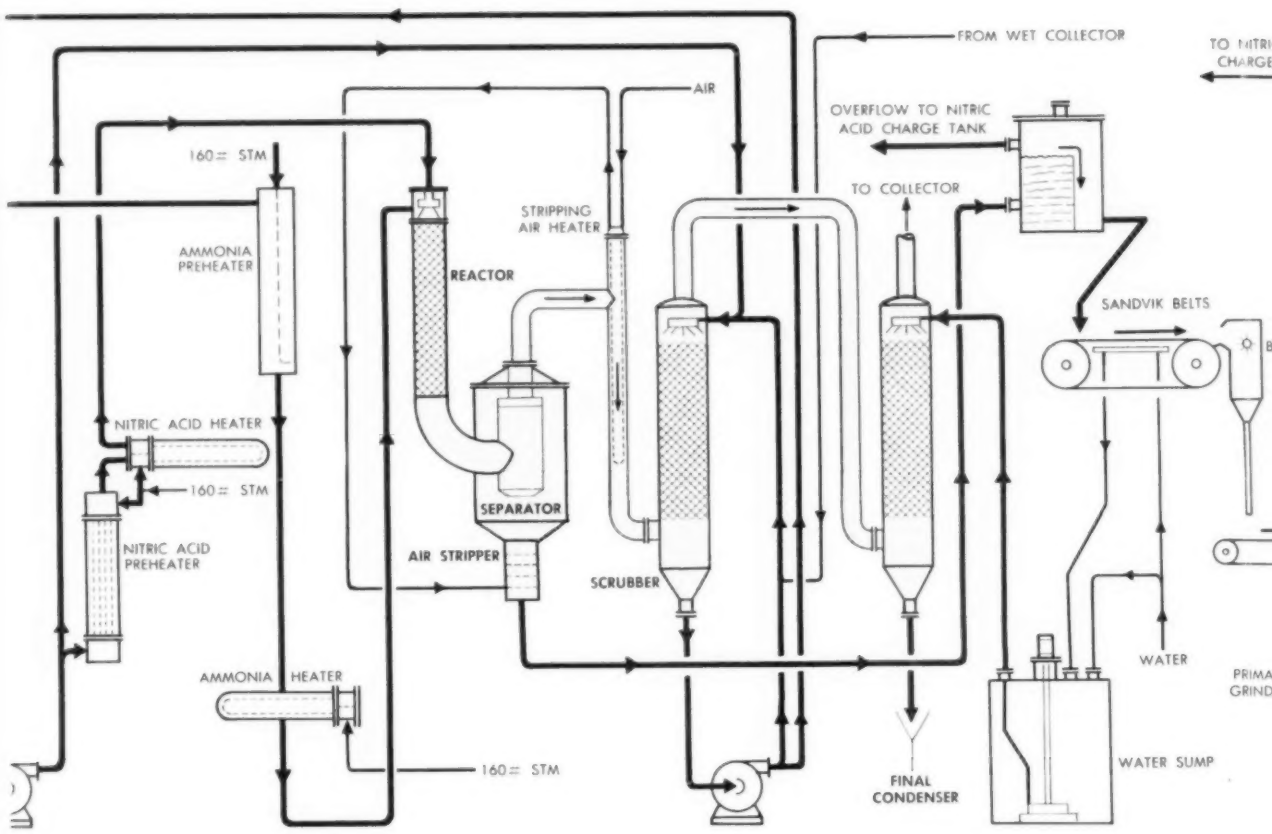
Effluent air from the top of the separator is cooled and sent to a partial condenser to remove ammonium nitrate and water vapor, which is recycled back to the process.

Molten ammonium nitrate flowing from the separator enters a weir box, which distributes it on water cooled, continuous, stainless steel cooling belts.

Separate aluminum pans containing cooling water are located just under the top half of the belts so that the surface of the water is in contact with the underside of the belts.

Solidified ammonium nitrate is removed from the belt by a doctor blade, entering a breaker where the ammonium nitrate is broken into pieces of suitable size for handling by the feed conveyor to the grinders. The ground material is screened on a double surface vibrating screen with oversize particles being recycled to the grinders and fines being returned to the process.

The product material from the screens is fed to a coating drum where diatomaceous earth is used as the coating agent. Final product is fed to a bagging hopper and automatic bagging machine for storage or shipping purposes.



Operating Conditions—The reactor temperature is between 400 and 460°F at about 50 psig. Stripper air is preheated. Molten ammonium nitrate leaving the air stripper portion of the reactor is at 380-400°F.

Product Yields—Yields of 98% and better across the reaction system have been realized.

Final product is crystalline, and contains 0.3% or less moisture and about 3% diatomaceous earth coating. Particle size is controlled by the grinders and screens, and can be regulated as desired.

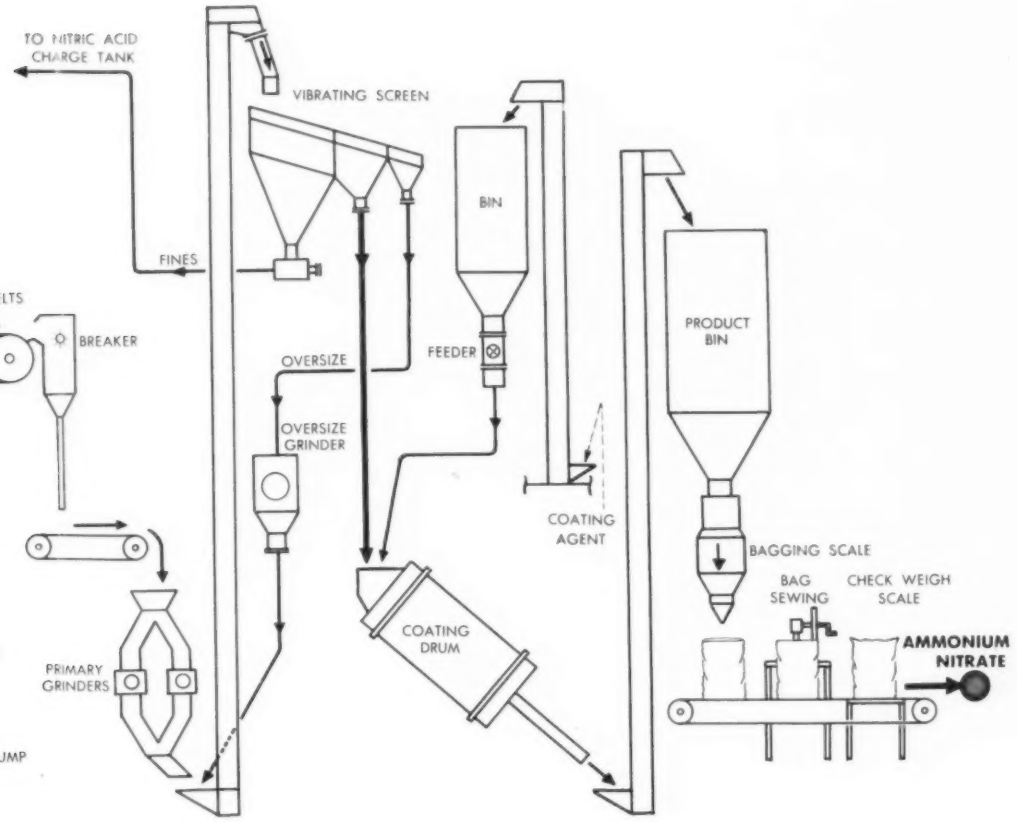
Equipment—Corrosion can be a serious problem in an ammonium nitrate installation. For the Stengel-C&I process, type 304 ELC is an economical and satisfactory material for most of the process equipment.

Utilities—Typical utilities needed for the process are: steam, 1000 lb/ton product; power, 19 KWH/ton product; and water, 2000 gal/ton of product.

Economics—For a plant producing 225 tons of ammonium nitrate per day at an average location, the plant cost is expected to be about $1.0 to 1.25 million, with the cost per ton of production reportedly at least one dollar less than that for other processes.

Installations—Existing installations using this process are at: Commercial Solvents Corp., Sterlington, La., solid and solutions products plants; Atlas Powder Co., Tamaqua, Pa., solid product; Northwest Nitro-Chemicals, Ltd., Medicine Hat, Alberta, Canada, solid product; California Spray Chemical Corp., Richmond, Calif., solutions product; St. Paul Ammonia Products, Inc., St. Paul, Minn., solutions product; The Texas Co., Lockport, Ill., solutions product plant under construction; Fisons, Ltd., England, solutions product plant planned.

Licensor—The process is licensed by Commercial Solvents Corp. and available from The Chemical & Industrial Corp. of Cincinnati, Ohio.



Granular Ammonium Nitrate

. . . by the Stengel-C&I process

UNFOLD **FOR START OF PROCESS DESCRIPTION**

References—Further information about the Stengel process for ammonium nitrate can be found in:

(1) Dorsey, J. J., Jr., "Ammonium Nitrate by the Stengel Process," *Ind. & Engrg. Chem.*, Jan. 1955, pp. 11-6.

(2) Hester, A., J. J. Dorsey, Jr., and J. T. Kaufman, "Stengel Process Ammonium Nitrate," *Ind. & Engrg. Chem.*, Apr. 1954, pp. 222-32.

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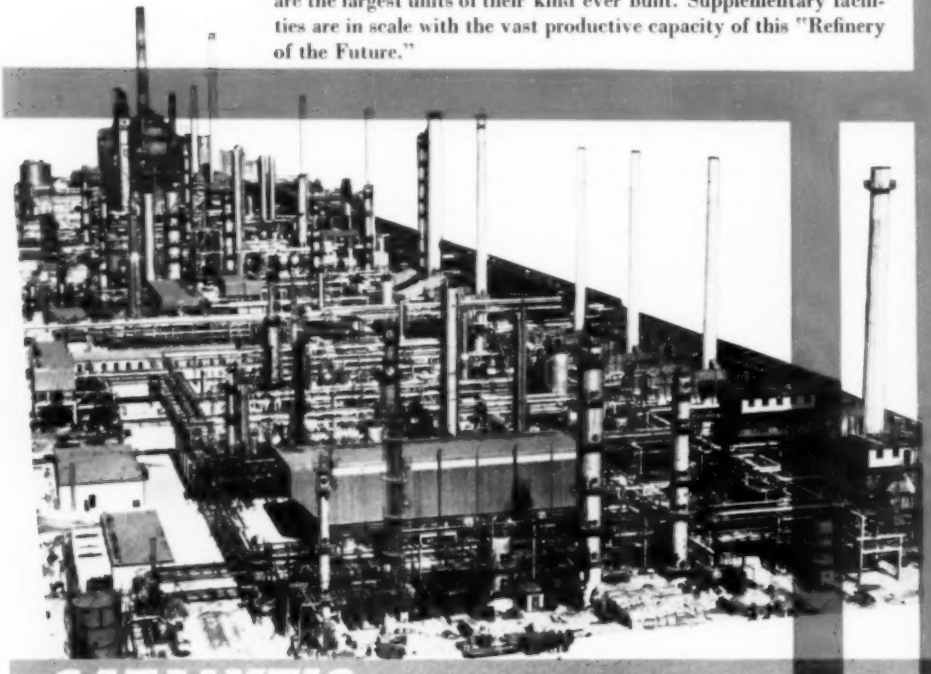
TIDEWATER—builds for the future

Tidewater Oil Company's new refinery near Wilmington, Delaware, is the largest refinery ever built as a single project. It has a total capacity of 130,000 barrels per day. Its crude unit, Orthoflow fluid catalytic cracking unit, fluid coker and 45,000 BPD Houdriformer are the largest units of their kind ever built. Supplementary facilities are in scale with the vast productive capacity of this "Refinery of the Future."



CATALYTIC—maintenance for the future

Catalytic's record in maintenance of refineries and other industrial plants has won it the maintenance contract for this gigantic new Tidewater enterprise. It assures Tidewater Oil Company of professional engineering type service that works in coordination with Tidewater's own staff. It means a minimum, highly productive, flexible force on the job only as required . . . with qualified mechanics available for turn-around periods.

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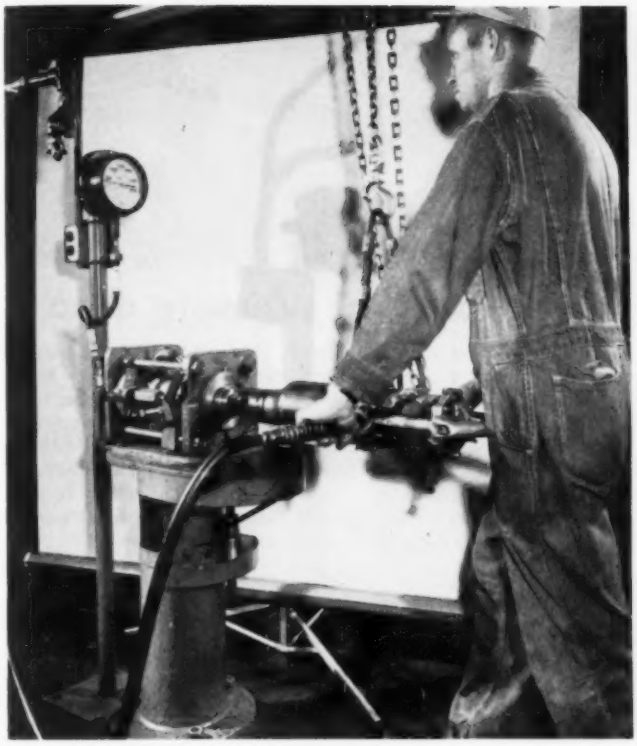
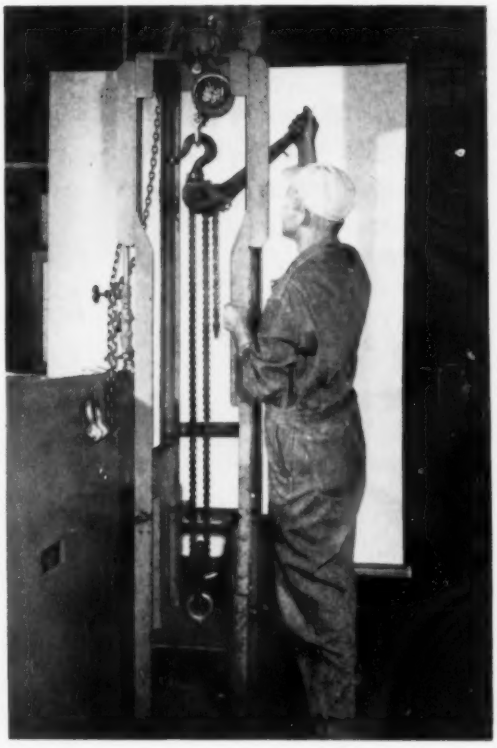
PLANT PRACTICES

By WILLIS A. BUSSARD, Associate Editor





Special testers keep tools in top condition

By D. I. Gantz*

THE maintenance tool room at Union Oil Co.'s Wilmington, Calif., refinery has found a way to keep lifting equipment and torque impact tools in better condition. The solution has been development of two special pieces of test equipment.

Lack of space in the tool room prevented storing test blocks, weighing 250 to 10,000 lb, which could be used for testing chain hoists. Instead, a 7-ft rack (above, right) was constructed of 2½-in. angle iron and dynamometer, a combination that permits testing all hoists with standard-length load chains. For other equipment with special-length load chains, a pair of posts set in concrete are used with the dynamometer for testing.

Impact tools are tested under simulated field conditions in another special rack (above, left) developed for this purpose. It consists of a hydraulic jack with a hollow ram, mounted in a horizontal position with the ram pushing against a stationary backup plate. A screw is inserted full length through the hollow ram, the floating head and the backup plate. A nut protrudes on each end of the assembly. The impact tool is tested by tightening the nut. The resulting pressure applied to the hollow ram is registered in ft lb torque by an easy-to-see hydraulic gage.

*Mr. D. I. Gantz is the tool room foreman at the Los Angeles Refinery of the Union Oil Co.

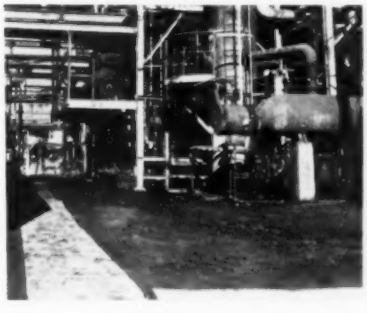
Rubber walkways will last longer

WHAT started out as a temporary expedient has turned into a permanent fixture at the Wyandotte Chemicals Corp. petrochemical plant in Wyandotte, Mich.

The glycol plant, located next to the larger lime plant at the same location, had difficulty maintaining dry walkways between buildings. But by borrowing a cast-off part from its neighbor, the glycol unit has solved the problem.

Worn conveyor belts from the lime kilns, originally used to carry limestone to the kiln hoppers, now serve as rubber walkways. They take the place of older concrete walks and have proved superior to concrete for maintenance and portability.

The conveyor belts shown here have been down for more than seven years and show no appreciable wear. They are part of more than 500 ft of walkways of this kind used in the glycol plant. The belts are made with a rubber surface over a fiber core.



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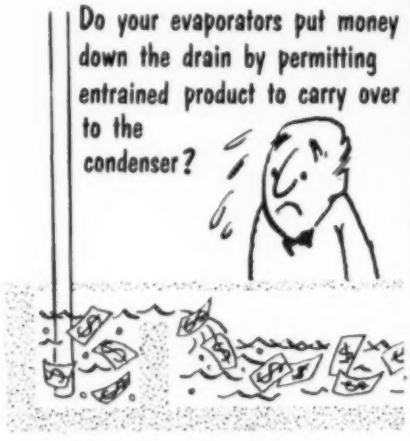

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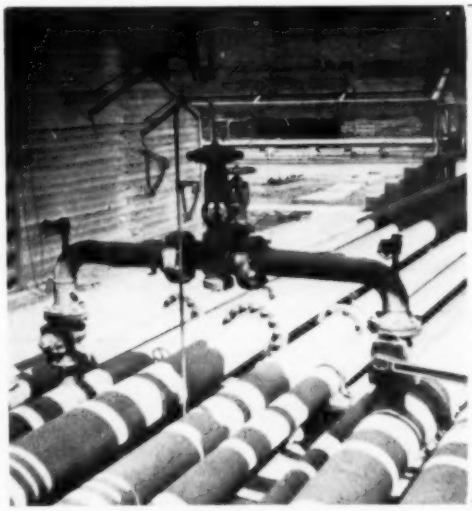
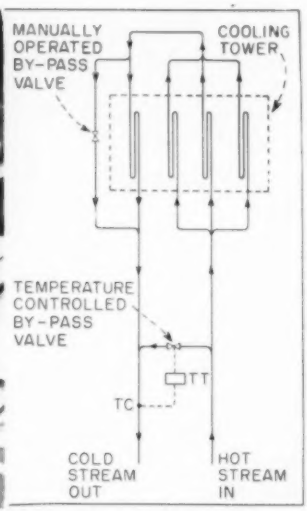
Mixer gives constant pressure drop

HERE'S a solution to some mixing problems that Atlantic Refining Co. had at its Philadelphia refinery—an improved type of "Knot Hole" mixer. It is being used for mixing two or more fluids or fluid and solid.

Developed by Albert J. Ferkel, now assistant superintendent of the chemicals department, it is used in departments throughout the refinery. The important advantage of this mixer is that it gives the same pressure drop and degree of mixing regardless of the rate of throughput of mixing materials. As have other developments at the same refinery, the mixer has been patented and is available to other companies in the United States.





Cooling temperatures kept constant

THE difficulty of maintaining constant cooling-tower temperatures, in the face of day-to-night and summer-to-winter atmospheric changes, can be eliminated. By using proper controls at its natural gasoline facilities near Sunray, Texas, Shamrock Oil and Gas Corp. has solved the problem of cooling-tower temperature control.

Cooling towers are arranged as shown in the above sketch—so that vapor goes through the first 3 passes in parallel. The partially condensed throughput is then combined and sent through the fourth cooling tower pass. If the process stream has a constant final outlet temperature, regardless of the time of day or season, plant operation is naturally better. To achieve this, the plant installed a by-pass system that allows different degrees of cooling during atmospheric temperature changes.

The by-pass system combines a manual control for large seasonal temperature changes, and an automatic control for smaller changes during the

1942 TRECO 1957

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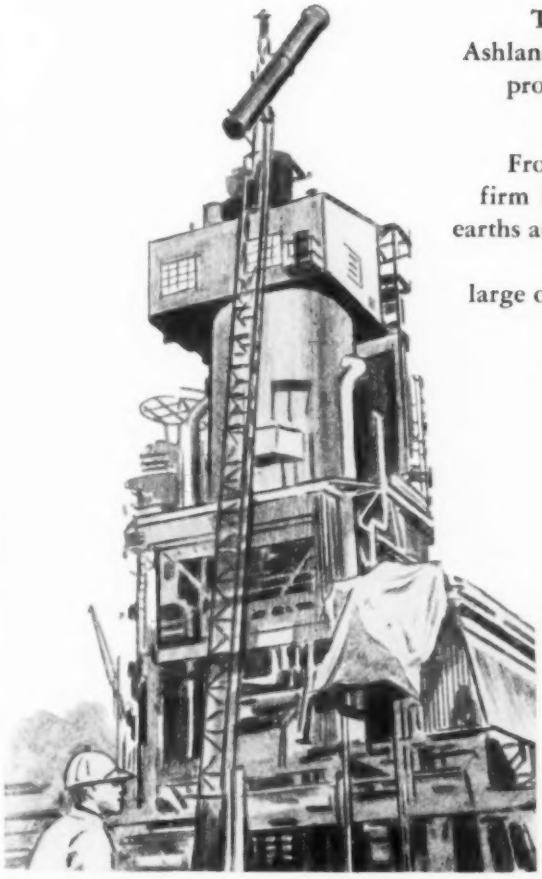

TRECO'S first job in 1942 was a small contract from Ashland Oil Refining Company of Ashland, Kentucky. The prompt and efficient execution of this contract brought several more as each preceding one was completed.

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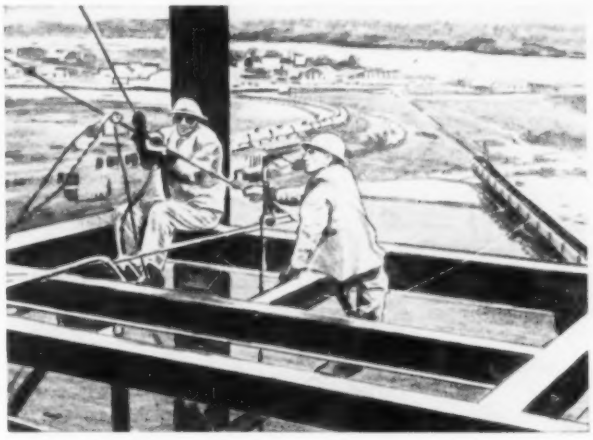
Now, on our 15th Anniversary, we are most grateful to those companies whose first contracts played such an important part in our operations.



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"And listen . . . with that new AIRETOOL Automatic Expansion Control System, my gang rolls such perfect, tight tube joints that I can forget about leaky tube joints.

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course of a day. The manual control adjusts the amount of the process stream through by-passing the fourth cooling tower pass. The automatic temperature control—shown in the photograph—adjusts the amount of the process stream by-passing all four cooling-tower passes.

Parka turns winter into summer

FACED with a tight building schedule in erecting a brick chimney during winter months, M. W. Kellogg Co. licked it by creating—and trapping—an artificial summer.

During construction of a 90-ft-high brick chimney in Ohio, the company was faced with temperatures ranging from 30 down to 9°F and, as it turned out, 18 days of rain, sleet and snow. Despite these conditions and one of the most severe winter storms in the history of Lorain, Ohio, the chimney was built in two months.

A nylon parka was erected around the top working area of the chimney. It was secured to the brickwork and an interior skeletal frame with drawstrings at bottom and top. As the chimney rose upward the parka rose with it.

Inside the nylon parka, lighting units and kerosine stoves were installed. This permitted workmen to erect eight to nine feet of masonry at a stretch in relative comfort. Because the tarpaulin was coated with neoprene, both wind and weather were kept outside and the fabric could withstand the whipping of winter winds.

Sun Oil Co. cracking unit at Marcus Hook, Pa.

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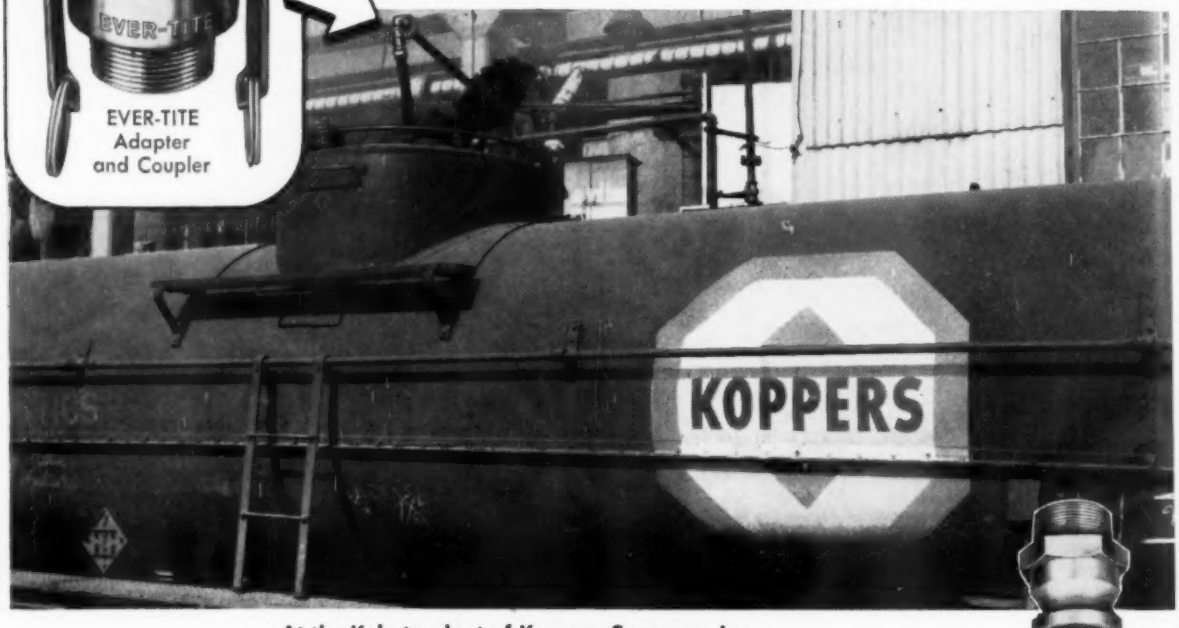

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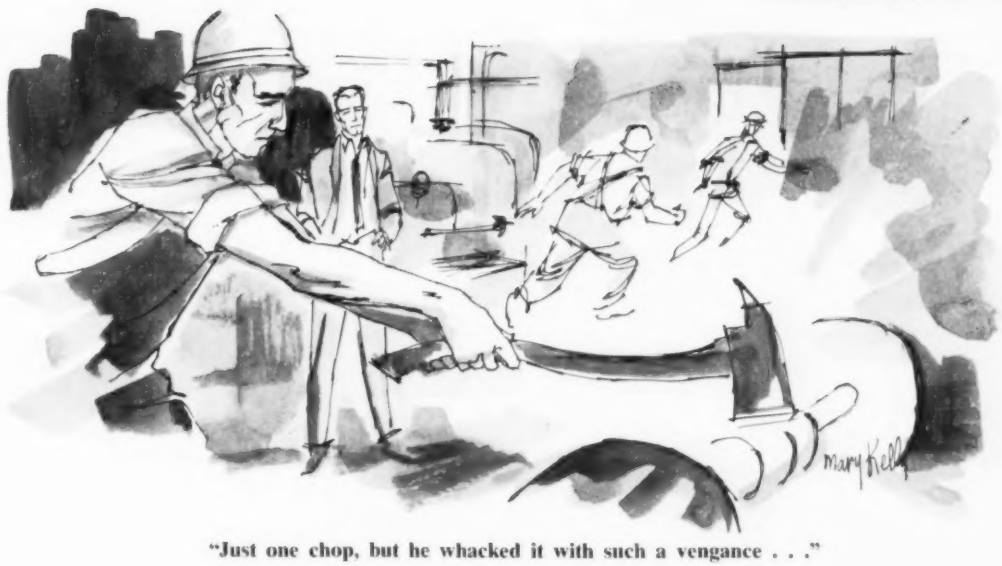

"Just one chop, but he whacked it with such a vengance . . ."

Cruse Blows His Fuse

CRUSE is not usually a very excitable person. In his job, you can't afford to go off half cocked. An operator on a still can get excited and shut down, and you've lost only one unit. But once you get excited and shut down all your utilities—power, steam, and water—you've lost a whole expensive refinery.

This particular day, though, Cruse really lost himself. The generators set off the trouble—the same old generators Cruse had fought from the beginning. This was an old tandem rig with two generators on the same driver, tied together through a shaft coupling. The rig was supposed to give the power plant a little standby power—our generating facilities were loaded to the hilt and we had but precious little stand-by for repairs or breakdowns.

So, we picked up these old generators at a bargain, had them rewound and overhauled, and were about to test them out.

I went over to the power plant to see how the experiment would turn out. Soon as I walked in, I knew I was in the wrong place. Cruse was running around like he had his head tucked in his hip pocket.

He spotted me, "I toldja from the first we shoulda gone out and bought a new machine instead of this pile of junk. This is probably the first generator ever made. Why do I have to get saddled with it? Why?

"You want to know what's the matter? I'll tell you what's the matter—these damned old relics are out of phase! That's what's the matter! How you gonna phase out two machines on the same shaft if the windings are out of phase?"

As Cruse yelled on, I regretted getting involved in the first place. "What are we gonna have to do?" I wanted to know.

"What are we gonna have to do, he says!" I was glad Cruse could understand what I was saying. "We're gonna have to take one machine out and rewind it, that's what we're gonna have to do."

"If you say so, Cruse, but I think we better call the Old Man and let him know his baby's not doin' so well."

"Yer damn right we're gonna let him know. Never shoulda got these old antiques to begin with. My power plant's gonna look like a museum."

The Old Man showed up and Cruse gave him the picture. "Time we finish paying for this thing, we coulda bought two brand-new machines," he concluded.

"Well," the Old Man said, "let's settle back and see what we got here before we go tearing the thing out." He was thinking hard and it took a little time.

"Cruse, you give up to easily," he said finally. "Have a machinist disconnect that coupling between the generators."

Heavy Williams, our best machinist, was sitting on an old greasy box nearby. He motioned idly to his helper, Stravasnik. Heavy, at one time, was a walking war between beer and muscles, but over the years the beer had won out. So now Heavy moved only when necessary. Stravasnik did the work and Heavy did the thinking. The two of them had been together so long it was hard to imagine one without the other. I often thought that if Heavy got a toothache, Stravasnik would head for the dentist.

Stravasnik was a long one, and when he stood up, he had to do it in pieces. After this feat was accomplished, he started to work on the coupling.

"While Stravasnik is taking that coupling apart, have your electricians separate the machines electrically and wire 'em up so the outboard generator runs as a synchronous motor," the Old Man told Cruse.

In about a half hour, the stage was set.

"Now, Cruse, start up the turbine

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- to get exact moisture control for the precise atmosphere condition you need
- to provide precise atmospheric conditions for testing
- to increase your air conditioning capacity
- to DRY large quantities of fresh air from outdoors

The Niagara's Controlled Humidity Method using HYGROL moisture-absorbent liquid is

Best and most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result constantly and always.

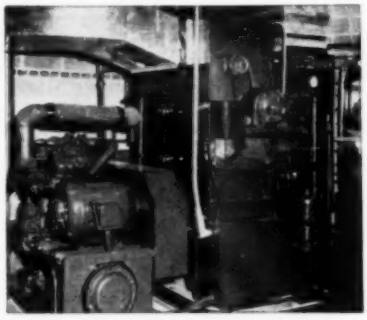
Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

Most flexible because . . . you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Easiest to take care of because . . . the apparatus is simple, parts are accessible, controls are trustworthy.

The cleanest because . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.

This method removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the leaving air. Heating or cooling is done as a separate function.



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and bring it up to about half speed. This ought to spin that outboard generator, that we've turned into a motor, exactly in phase with the generator. Right?"

Cruse guessed so, he said. He brought the machine up to speed.

"Now, get that fire axe off the wall there," the Old Man said to no one particular. Heavy motioned casually to Stravasnik, who brought the axe over to the generator.

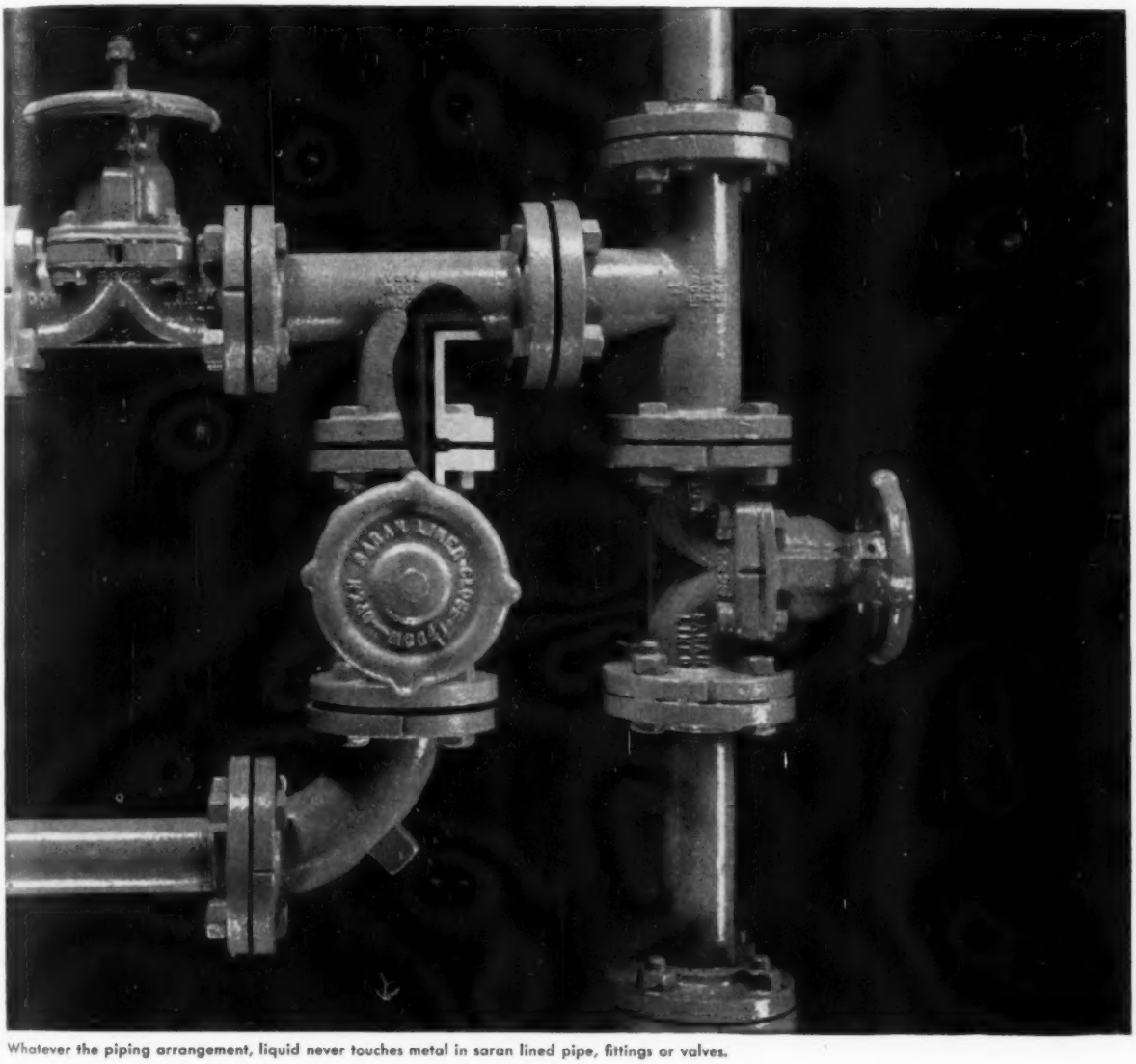
Well, I didn't have the faintest notion of what was going on, and I couldn't hear the Old Man's instructions to Stravasnik, so I was unprepared for what happened next. I thought the long guy had gone beserk. Even Heavy scrambled off his box and was clearing out, but fast.

Stravasnik swung that fire axe and clobbered the two disconnected halves of the coupling between the two generators. Just one chop, but he whacked it with such a vengeance that Heavy was half outside before he realized it was part of the job. Figuring Heavy knew the long boy better than I did, I was right behind.

When Cruse stopped the machines, we all gathered around the coupling. "All right, Cruse," the Old Man said, "you've got a match mark on each half of the coupling. Match 'em up, figure the lag and yer machines will be in phase. You might have to redrill one coupling, but it'll be a sight cheaper than re-winding a machine."

Cruse was surprised, but disappointed. It worked. He was going to have to live with those old generators. Personally though, I think he was tickled to death with his "relics." But ever since they were installed, he refers to the power plant as "a branch of the Smithsonian Institute."

• • •



Whatever the piping arrangement, liquid never touches metal in saran lined pipe, fittings or valves.

You can see why saran lined pipe cuts costly downtime

It's a rigid steel pipe lined with durable saran that corrosive liquids won't bother

Now you can pipe commonly used acids, alkalies and other corrosive liquids without worrying about corrosion. With saran lined pipe, the liquid never touches metal – in the pipe, valves or fittings. Corrosion can't get a start—downtime troubles are eliminated.

Because it is two pipes in one, steel swaged onto saran, it has high strength. In fact, saran lined pipe will withstand working pressures up to 300 psi. Saran lined valves and fittings are available for 150-psi and 300-psi working pressures.

You'll get other advantages when you use saran lined pipe. It's easy to fabricate and easy to install. Conventional pipe fitters' tools can be used for cutting and threading. And you can hang it as you would ordinary steel pipe.

If your operation can profit from long-lasting, corrosion-free piping, investigate saran lined pipe today. THE DOW CHEMICAL COMPANY, Midland, Michigan.

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High sensitivity at low cost
for plant, field, and laboratory

Now you can improve your process control or analytical service with an inexpensive, portable mass spectrometer. CEC's completely new 21-611 adapts easily to installation in a trailer, on a bench — wherever there is space for the 115-lb unit. The instrument covers mass range 2 through 80, with automatic scanning from mass 12 to 40 requiring only 3 minutes. Extremely rugged and simple to operate, the 21-611 consists of separate electronic and vacuum modules which may be operated stacked or apart. Ingenious design for trouble-free operation has eliminated the conventional cold trap, one forepump, magnet shunt, and several vacuum tubes. Investigate this outstanding value by calling your nearby CEC field office, or write for Bulletin CEC 1843-X2.

Capable of analyzing minute samples of gases, gaseous mixtures, or vaporized liquids with precise accuracy, the economical 21-611 offers automatic programming of control mechanisms and a unique scanning dial which eliminates mass marking. Complicated sample introduction procedures are unnecessary with the simplified batch inlet system featuring a single all-metal rotary valve. Entire portable unit weighs only 115 pounds.

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Do You Know These Words?

By B. H. WEIL

A regular department intended to help administrators and operating men keep abreast of technical names and processes in the petrochemical field.

Morpholine

Morpholine, pronounced **"more**-foe-lean," is one of the many petrochemical derivatives of ethylene oxide. It has the formula $O(CH_2CH_2)_2NH$—actually a six-atom ring in which two atoms are oxygen and nitrogen and the other four are carbon. A colorless liquid with an "amine" odor, it mixes readily with water.

While it boils at 129° C, above the boiling point of water, the vapor pressure of morpholine in water solutions is about the same as that of water, so that both evaporate at the same rate. This is of commercial importance in the formulation of water-resistant waxes, polishes, and adhesives. Morpholine also finds use as solvent for dyes and resins, as a corrosion inhibitor for boiler water, in emulsifying agents, in the preparation of rubber vulcanization inhibitors, etc.

Petrochemically, morpholine is derived from ethylene oxide and ammonia; diethanolamine, prepared from these, is said to be an intermediate. Ethylene oxide is produced from ethylene, obtained in turn from refinery cracked gases or the deliberate cracking of petroleum fractions. Ammonia is a derivative of hydrogen, obtained from natural gas or petroleum fractions via the "methane-steam" reaction or partial combustion.

The first petrochemicals had rather simple molecular structures. That of morpholine, while not really complicated, illustrates how the "simple" petrochemicals can in turn be used as building blocks for more complex structures. Morpholine is thus of both academic interest and, obviously, of industrial importance.

Methyl Cyclopentadienyl Manganese Tricarbonyl

Methyl cyclopentadienyl manganese tricarbonyl is a very new petrochemical which may become quite important as an antiknock agent for use in gasolines, alone or as a supplement to tetraethyl lead. It is a straw-colored liquid, and is heavier than water per unit volume. It freezes at 34.6°F, boils at 451°R, and mixes readily with hydrocarbons. Pronounced **"meth**-ihl **sigh**-klo-**pen**-ta-dye-**een**-ihl **mang**-gah-neese try-**car**-bohn-eel," it has the formula $(CH_3\text{-}C_5H_4)Mn(CO)_3$.

Certain organometallic compounds —substances in which metal radicals are linked directly to carbon atoms— are well known as antiknock agents, the metals being the active materials and the organic (hydrocarbon-radical) parts largely providing a means of dissolving the compounds in gasoline. Tetraethyl lead is of course the best-known metal-organic compound, but little has ever before been published on the antiknock properties of manganese compounds. Some carbonyls (metal-CO compounds) are known antiknocks; iron carbonyl, for example, is an excellent, inexpensive one, but its combustion products are abrasive. Apparently, cyclopentadiene-metal compounds have desirable properties as hydrocarbon additives; cyclopentadienyl iron (ferrocene) has been previously described in this series as a potential gasoline or fuel-oil additive.

Raw materials for this new compound are methyl cyclopentadiene (a constituent of many refinery streams), metallic sodium, manganous chloride, and carbon monoxide (obtainable as a coproduct with hydrogen by the partial combustion of hydrocarbon gases or by the "methane-steam" reaction). Thus this compound, if produced commercially, will join tetraethyl lead in the ranks of petrochemical antiknocks.

Methyl cyclopentadienyl manganese tricarbonyl has been introduced as an experimental material, one that will become commercial if further study solves certain problems and demonstrates its economic attractiveness as an antiknock or TEL-supplement for use in automotive and/or aviation gasolines. At the least, it is an interesting new petrochemical.

Mr. Weil is chief editor of Esso Research and Engineering Co.'s technical information division, Linden, N. J. He was until recently with Ethyl Corp.'s research and engineering department.

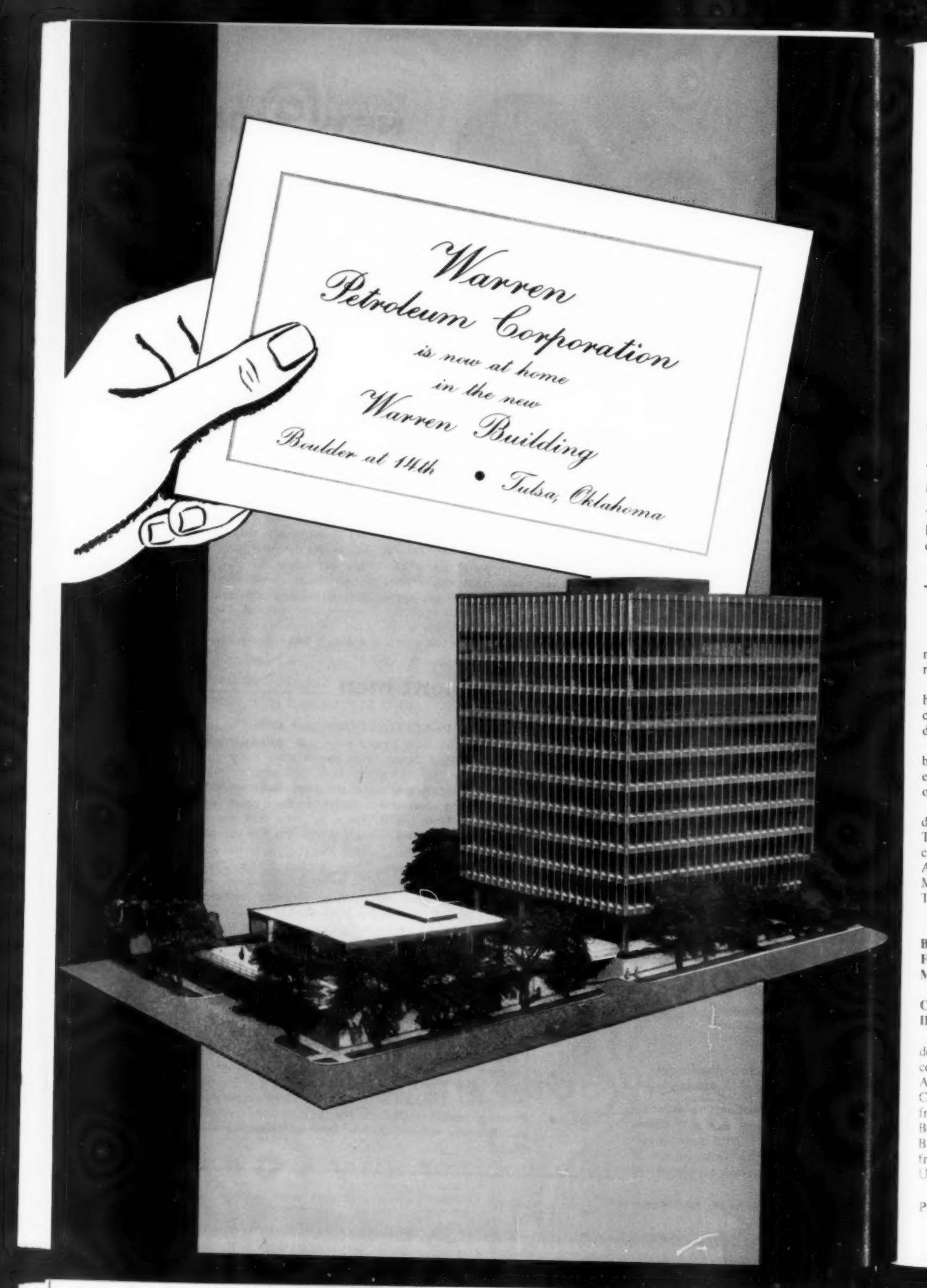
For management men

BECAUSE SUMMER REPLACEMENTS are hard to find, many companies are now encouraging their employes to take their vacations outside the usual summer period. Some firms are offering bonus days for non-summer vacations, others, where two-week-or-more periods are involved, are insisting on split vacations. One company makes vacations a part of its war on absenteeism. Employes there must work at least 40 full weeks one year to qualify for a full two week vacation the next year. Less than 40 full weeks progressively cuts into vacation time.

SOME OIL COMPANIES are "hiding" their technical men. The purpose: to keep competitors from hiring away their hard-to-get engineers and scientists. The traditional policy of encouraging publicity about professional men for morale purposes is proving a two-edged sword. At least two firms now frown on permitting their men to be identified in their reports. And at least one company actually stockpiles extra engineers to allow for losses to other firms.

THE SWING SHIFT is hard to make palatable to most employes. That's why Du Pont is promoting a swing shift selling campaign that points out three appeals of nighttime work:

- Relationship of nightwork to our economy—high volume, low-cost production, more leisure time, more spendable income.
- Glamour and dignity of swing-shift work—by comparison with others who patrol the night beat, newspapermen, policemen, entertainers. The idea is to build an esprit de corps.
- Practical benefits—daylight for do-it-yourself projects, recreation and shopping without crowds, time for home life and community affairs.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Petroleum Corporation
is now at home
in the new
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Gulf shuffles refinery management

Gulf Oil Corp. has reassigned several people in refinery management as part of its policy to diversify the experience of its employes.

R. C. Faulkner, general manager at Port Arthur, has been transferred to the Pittsburgh general offices to head the mechanical design and construction activity of the Pittsburgh manufacturing department's engineering division.

J. O. Timms has succeeded Faulkner at Port Arthur. Timms has been general manager of the Philadelphia refinery.

Timms' successor at Philadelphia is **T. A. Dietz,** who was manager of engineering at the refinery.

D. E. Hart, general manager of the Toledo refinery, has been moved to Port Arthur to the post of manager of operations.

General manager of the Cincinnati refinery, **A. A. Niehenke,** has been transferred to Toledo to replace Hart.

The new general manager at Cincinnati is **T. F. Hogan,** who was manager of operations at Port Arthur, the post D. E. Hart has now taken.

H. M. Vaughan, manager of engineering at Port Arthur, has taken the same job at the Philadelphia refinery, succeeding Dietz.

To take the post of manager of engineering at Port Arthur, **R. S. Justiss** has been transferred from the Pittsburgh offices, where he was director of mechanical design in the manufacturing department's engineering div.

J. N. Miller, director of process engineering at Port Arthur, has been assigned to the process design division in Pittsburgh.

Miller is succeeded by **B. A. Kreiter,** who was in the process design division in Pittsburgh.

Humble Oil & Refining Co. has announced these changes at its Baytown refinery:

J. H. McClintock and **A. A. Sanders** have been promoted to senior chemical engineers in the technical service division.

J. A. Snyder and **E. L. Wilson** have been named senior research chemical engineers in the research and development division.

McClintock and Sanders hold B.S. degrees in chemical engineering from Texas University; Wilson, a B.S. in chemical engineering from Texas A. & M. College; and Snyder B.S. and M.S. degrees in the same subject from Tulane University.

Additions to the staff are as follows:

Research and development division: **B. L. Beck, G. R. Bookmyer, J. E. Frandolig, L. M. Johnson, W. N. Mitchell,** and **W. C. Thompson.**

In the engineering division: **C. D. Corbell, J. E. Fitch,** and **W. J. Ruez, III.**

Beck holds B.S., M.S. and Ph.D. degrees from the University of Wisconsin. Frandolig, a B.S. from Texas A.&M. and M.S. from Iowa State College. Thompson, B.S. and M.S. from the University of Mississippi. Bookmyer, Johnson and Mitchell hold B.S. degrees in chemical engineering from the University of Detroit, Texas University, and Mississippi State College, respectively. Corbell has a B.S. from Mississippi State College. Fitch holds a B.S. from Louisiana State University, and Ruez took his B.S. at Texas A.&M. College.

R. L. Hockley, Baltimore consultant to the chemical industry, has been elected to the board of Amoco Chemicals Corp., petrochemical subsidiary of Standard Oil Co. (Ind.) He will be particularly interested in counseling the company about development and marketing activities.

His career included a series of positions with W. W. Lanahan Co., Worthington Pump and Machinery Co., G. D. Penniman, Jr., & Associates, and the Davison Chemical Corp., of which he was president. He was vice-president of Olin Mathieson Chemical Corp. from 1954 to early 1957.

Mr. Hockley attended Baltimore Polytechnic Institute, Phillips Andover Academy and Cornell University.

Herbert A. McIntosh has joined The Texas Co. as a chemical engineer. He is a recent graduate of the Georgia Institute of Technology. He begins work at the research and technical laboratories in Port Arthur, Texas.

John H. Loudon has been elected chairman of the Shell Oil Co. board of directors. He succeeds Sir Francis Hopwood, who has retired.

F. J. Stephens, manager director of the "Shell" Transport and Trading Co., Ltd., and other companies, has filled the vacancy on the board.

R. D. Meagher has been named assistant manager of the British American Oil Co. refinery at Calgary. A graduate of McGill University, Meagher began with B-A in 1938 at Montreal East refinery. Most recently he was head project engineer of the head office manufacturing engineering department.

A. P. Frame, vice-president and director of Cities Service Co., has been elected a director of the Coordinating Research Council, Inc., which conducts research for the common interests of the petroleum, automotive and aviation fields.

Mr. Frame

He is also president and director of Cities Service Research and Development Co., vice-president and director of Cit-Con Oil Corp., Petroleum Chemicals, Inc., and Mid-South Chemical Co.

Hamilton P. Caldwell, Jr. has been appointed manager of the Socony Mobil Oil Co. refinery in Augusta, Kan. He had been manager of the East Providence, R. I., refinery. He succeeds **J. W. Glass,** who is retiring after 37 years of service.

Joseph E. Penick, supervisor of light oil operations in the manufacturing department, has been named manager of East Providence.

Bonner H. Templeton, assistant manager of the process promotion division, has succeeded Penick.

A. E. Marshall, Jr., and **B. R. Starzanski** have been named assistant managers of the process promotion division. They both joined Socony as members of the refinery engineering division.

Changes in key production personnel in Monsanto Chemical Co.'s Organic Chemicals Division have been announced.

Dominic Dana, manager of the Avon, Calif., plant, has been named general superintendent of warehouse

rapid
short flame combustion
...even on residual fuel oil

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VORTEX BURNER

Here is a versatile unit that gives rapid, clean combustion on a wide range of fuels including Bunker C, No. 6, light oil, any gas ... even liquid organic wastes.

Combustion is 80% completed within the burner itself and takes place with a whirling, short flame that attains heat release rates of over 1,000,000 BTU/hr per cu ft. Products of combustion are clean and sufficient excess air for tempering the products may be introduced through the burner itself without causing smoke or instability.

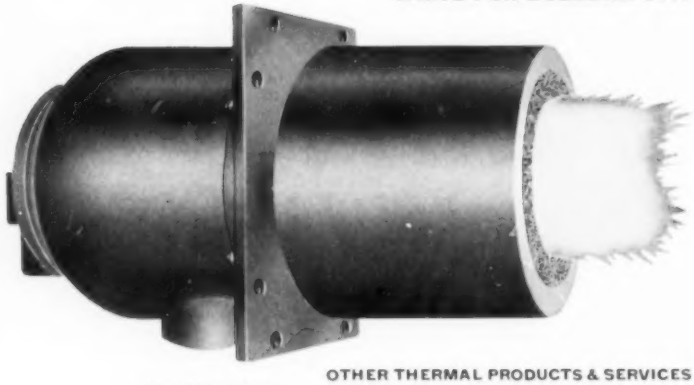
standard models available...

Complete units from 3,500,000 BTU/hr to 50,000,000 BTU/hr are available and may be fitted for steam, compressed air or mechanical atomization. With dual fuel arrangements switching from gas to oil is accomplished without shutdown.

instant ignition...

Gas-electric or torch ignition allows full ignition in a few seconds—even with a cold burner.

WRITE FOR BULLETIN #111



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REPRESENTATIVES IN PRINCIPAL CITIES

IHEA

and inventories for the John F. Queeny plant.

Paul W. Edwards, general manufacturing superintendent at the Queeny plant, has become plant manager at Avon, succeeding Danna.

Paul A. Kannapell, assistant engineering superintendent of the William G. Krummrich plant, has been named general manufacturing superintendent at the Queeny plant.

C. F. Feuchter, formerly manager of planning, has been made manager of manufacturing economics for American Oil Co., a new title.

Roscoe F. Stahl has been named assistant manager of manufacturing economics. He was associate director of research at Texas City and is now headquartered in New York.

H. K. Wheeler, assistant plant manager at the El Dorado refinery, has assumed the newly created post of director of planning in the research and development department.

Guy L. Honeycutt, operating superintendent at the Yorktown, Va., refinery, has succeeded Wheeler at El Dorado.

Feuchter took B.S. and M.S. degrees at M.I.T.

Stahl holds B.S. and M.S. degrees from the University of Oklahoma. He joined Amoco in 1942 as a chemical engineer in the R&D department. He became associate director of the development division in 1954.

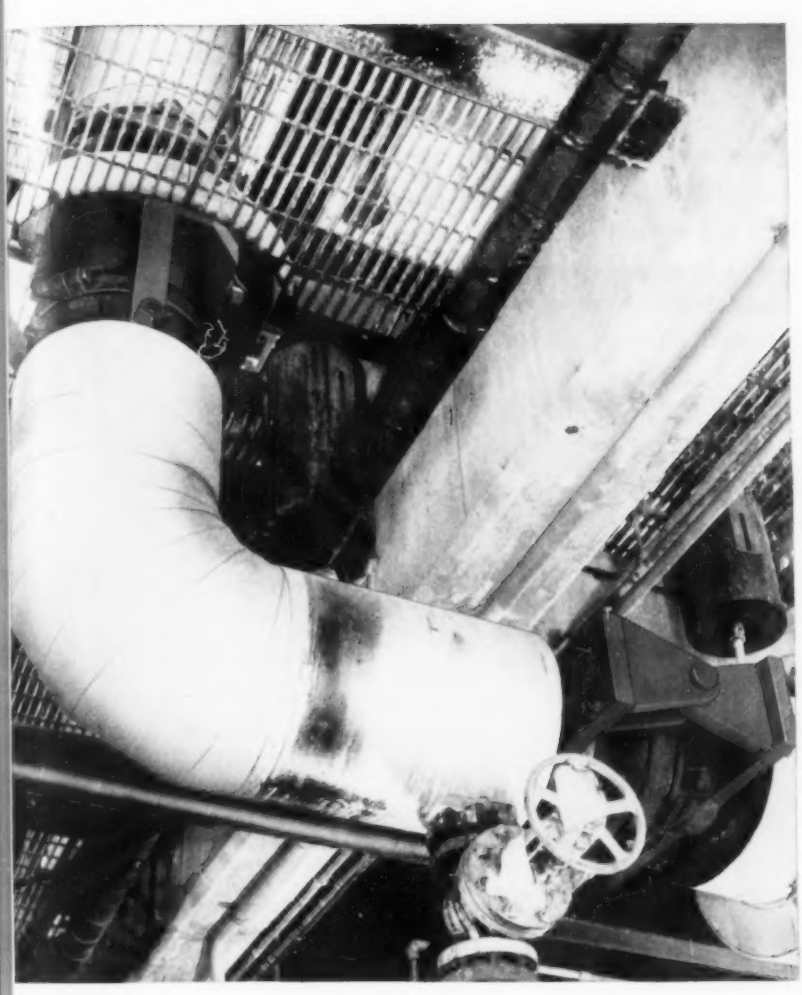
Wheeler began with Standard Oil Co. (Ind.) in 1944 as a design engineer at Whiting, Ind. He transferred to Pan-Am Southern Corp. in 1950 and went to El Dorado as assistant technical director. After a series of promotions he became assistant manager in 1956. He is a graduate of the University of Cincinnati.

Honeycutt first joined Amoco in 1936, served in the army from 1941-45, took a chemical engineering degree from the University of Texas, and rejoined the company in 1949. He was a division superintendent in the operating department at the time of his transfer to Yorktown in 1956.

Obituary

Dr. Harold S. Snow, 62, manufacturing vice-president and director of American Oil Co. died July 31.

Snow received his doctorate in chemistry from the University of Michigan and entered the oil industry in 1925 as a research chemist for Standard Oil Co. (Ind.) He became a vice-president of Amoco in 1954 and a board member in 1956.



THIS IS WHAT ADSCO MEANS BY SPECIAL JOINTS

The photo shows a small but very important section of an insulated, spring-suspended 8″ pipe line in the new Moundsville, W. Va., plant of the National Aniline Division of Allied Chemical & Dye Corp. At the point shown, the line is subjected to complex stresses which are completely resolved and placed in balance by the ADSCO Gimbal Expansion Joint, upper left, and the ADSCO Hinge Expansion Joint, lower right.

In the Gimbal Joint, two sets of bars are pinned to the octagonal ring at 90° to each other. The other ends of the bars, still at 90° to each other, are pinned to the pipe leading into the joint. Running through the center of the ring, with a slight clearance, is a nipple connecting two expansion elements. This gimbal arrangement permits the joint to absorb 6° of angular movement from two different directions: the left and right motion of the horizontal part of the ell and similar motion from other unseen upper horizontal piping at 90° to the plane of the lower piping.

A partner to the Gimbal Joint and an indispensable part of this piping system is the Hinge Joint shown lower right. This absorbs the angular rotation of the ell caused by the expansion and contraction of the vertical piping.

There are so many motions involved in this section that, under certain conditions, the octagonal ring of the Gimbal Joint could describe a circle. Yet ADSCO and National Aniline engineers were able to identify all the motions and absorb them economically and efficiently by the Gimbal and Hinge Joints.

ADSCO designs and manufactures many types of both standard and special joints for many purposes. Consult ADSCO on any piping problem.

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 (To obtain more data on advertised products see page 222)

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Our widely-experienced technical and manufacturing staff, including design, process, project and mechanical engineers, backed by half a century of "know-how," is at your service to assist you in applying low-temperature technology to your particular requirements. We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components "tailored" to your needs.

Air Liquide low-temperature air separation unit for producing high-purity nitrogen.

Similar A.L. unit for recovering hydrogen from coke-oven gas.

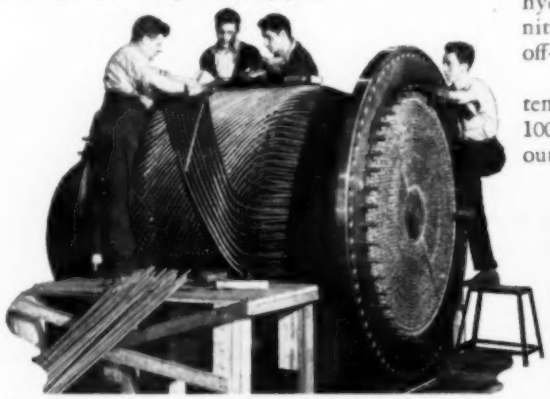
Ketona Chemical, at Birmingham, Alabama, has successfully inaugurated the first ammonia plant in this country designed exclusively around coke-oven gas as a source of hydrogen. The low-temperature gas separation units used at Ketona were designed and built by American Air Liquide.

A portion of Air Liquide's Engineering and Construction Division fabricating plant at Montreal, Que. Under fabrication here are numerous all-welded stainless steel shells to house component exchangers, vaporizers, rectification columns, etc., of the liquefaction equipment.

Low-temperature separation processes, for recovering atmospheric and hydrocarbon gases in tonnage quantities, are being used on a rapidly increasing scale in the United States.

Once confined to the separation of oxygen, nitrogen and the rare gases of the atmosphere, the low-temperature liquefaction process of separation is today successfully producing high-purity hydrogen, pure carbon monoxide, methane, ethylene, propane and nitrogen, from such gaseous mixtures as: natural gas, refinery off-gases and coke-oven gas.

During the past 50 years, Air Liquide (a pioneer in the low-temperature gas separation field) has designed and built more than 1000 hydrocarbon and air-separation plants for industries throughout the world. In the United States it is a leader in this field.



The fabrication of an Air Liquide wound tube-type exchanger can involve over 10 miles of intimately interwoven copper tubing to provide the necessary cooling surfaces in this specialized low-temperature equipment.

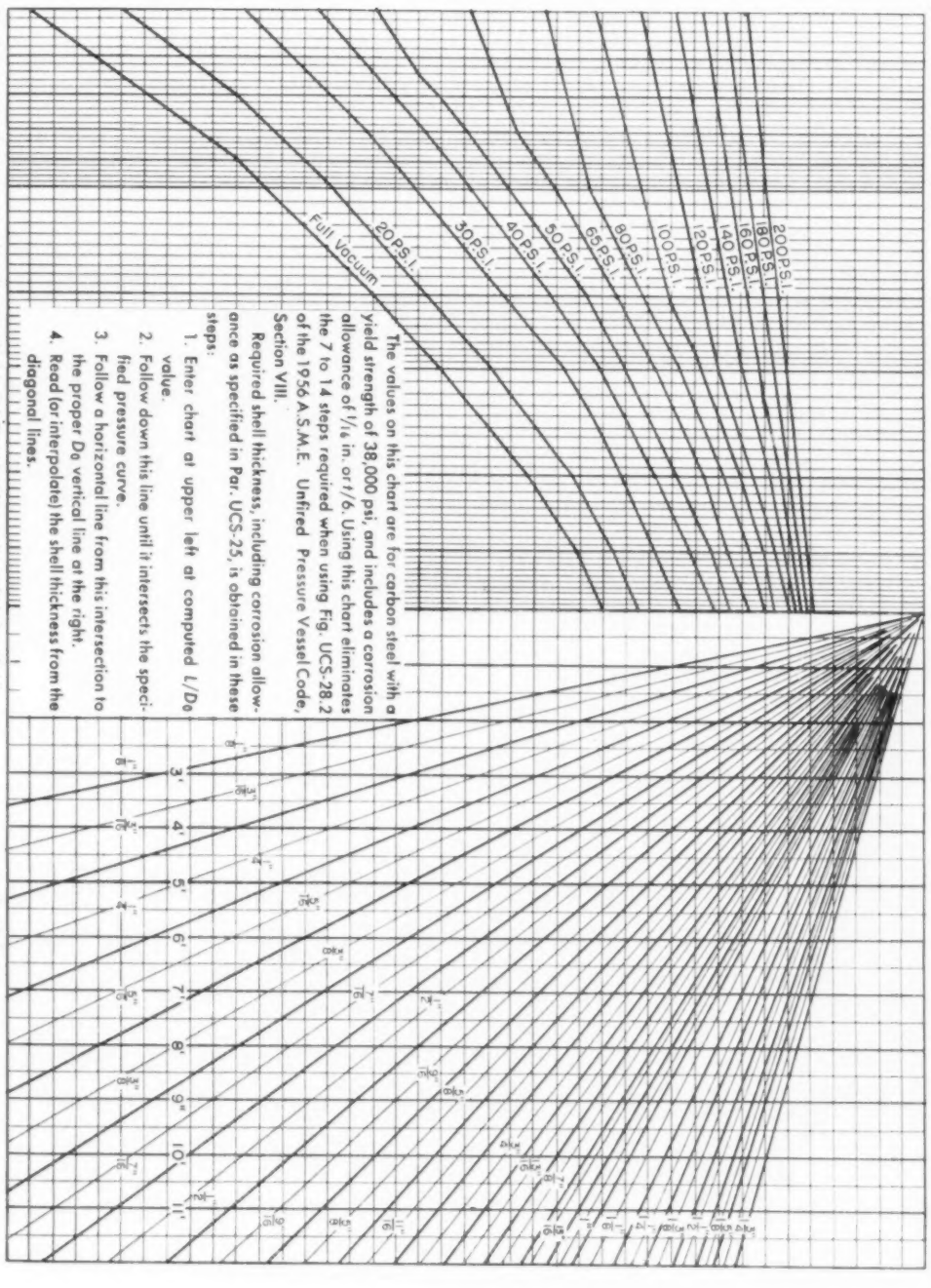
Centre of control panel for a large-tonnage oxygen plant includes a flow sheet for the operator's guidance. Once put "on stream", operation of Air Liquide low-temperature plants is almost entirely automatic.

L'Air Liquide, its affiliates and subsidiaries have offices and plants throughout the world: Algeria, Argentina, Belgium, Brazil, Cameroon, Canada, China, Egypt and Sudan, France, French Congo, French West Africa, Gold Coast, Great Britain, Greece, Indochina, Italy, Ivory Coast, Japan, Lebanon, Luxemburg, Madagascar, Malay States, Morocco, Netherlands, Paraguay, Portugal, Siam, South Africa, South-East Asia, Spain, Sweden, Syria, Tunisia, and the United States of America.

Unfired Pressure Vessels

Simplified External Pressure Shell Thickness Chart

Carbon Steel, at 300° F



The values on this chart are for carbon steel with a yield strength of 38,000 psi, and includes a corrosion allowance of 1/16 in. or t/6. Using this chart eliminates the 7 to 14 steps required when using Fig. UCS-28.2 of the 1956 A.S.M.E. Unfired Pressure Vessel Code, Section VIII.

Required shell thickness, including corrosion allowance as specified in Par. UCS-25, is obtained in these steps:

1. Enter chart at upper left at computed L/Do value.
2. Follow down this line until it intersects the specified pressure curve.
3. Follow a horizontal line from this intersection to the proper Do vertical line at the right.
4. Read (or interpolate) the shell thickness from the diagonal lines.

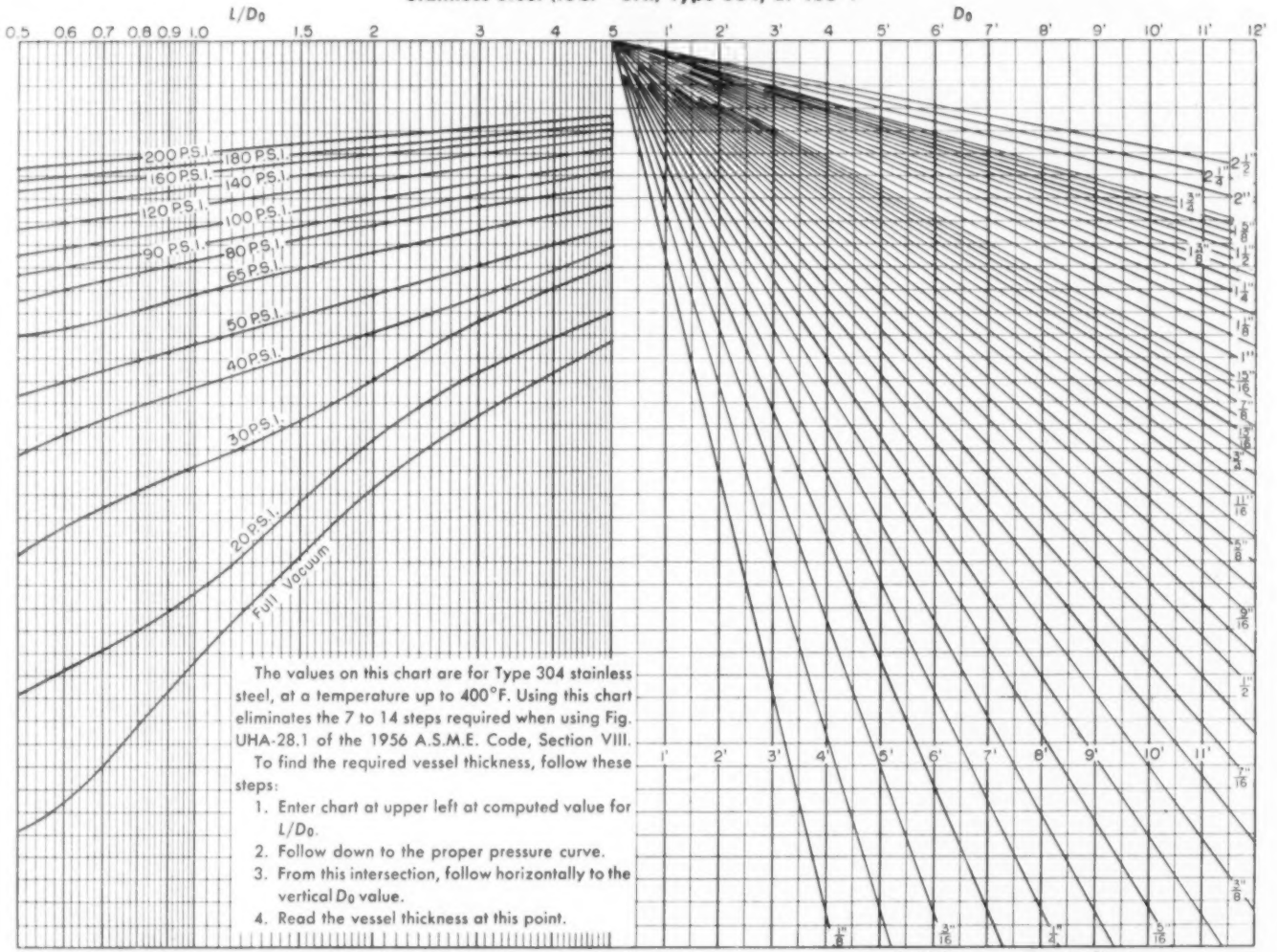
This chart is reprinted with permission from the copyrighted book, "The Unfired Pressure Vessel Code Simplified," by Mr. Robert Chase, P.O. Box 91, Lesnia, N.J.

L. R. McGann

For Chart on Stainless Steel, turn to page . . . 86

Simplified External Pressure Shell Thickness Chart

Stainless Steel (18Cr—8Ni) Type 304, at 400° F



The values on this chart are for Type 304 stainless steel, at a temperature up to 400°F. Using this chart eliminates the 7 to 14 steps required when using Fig. UHA-28.1 of the 1956 A.S.M.E. Code, Section VIII.

To find the required vessel thickness, follow these steps:

1. Enter chart at upper left at computed value for L/D_0.
2. Follow down to the proper pressure curve.
3. From this intersection, follow horizontally to the vertical D_0 value.
4. Read the vessel thickness at this point.

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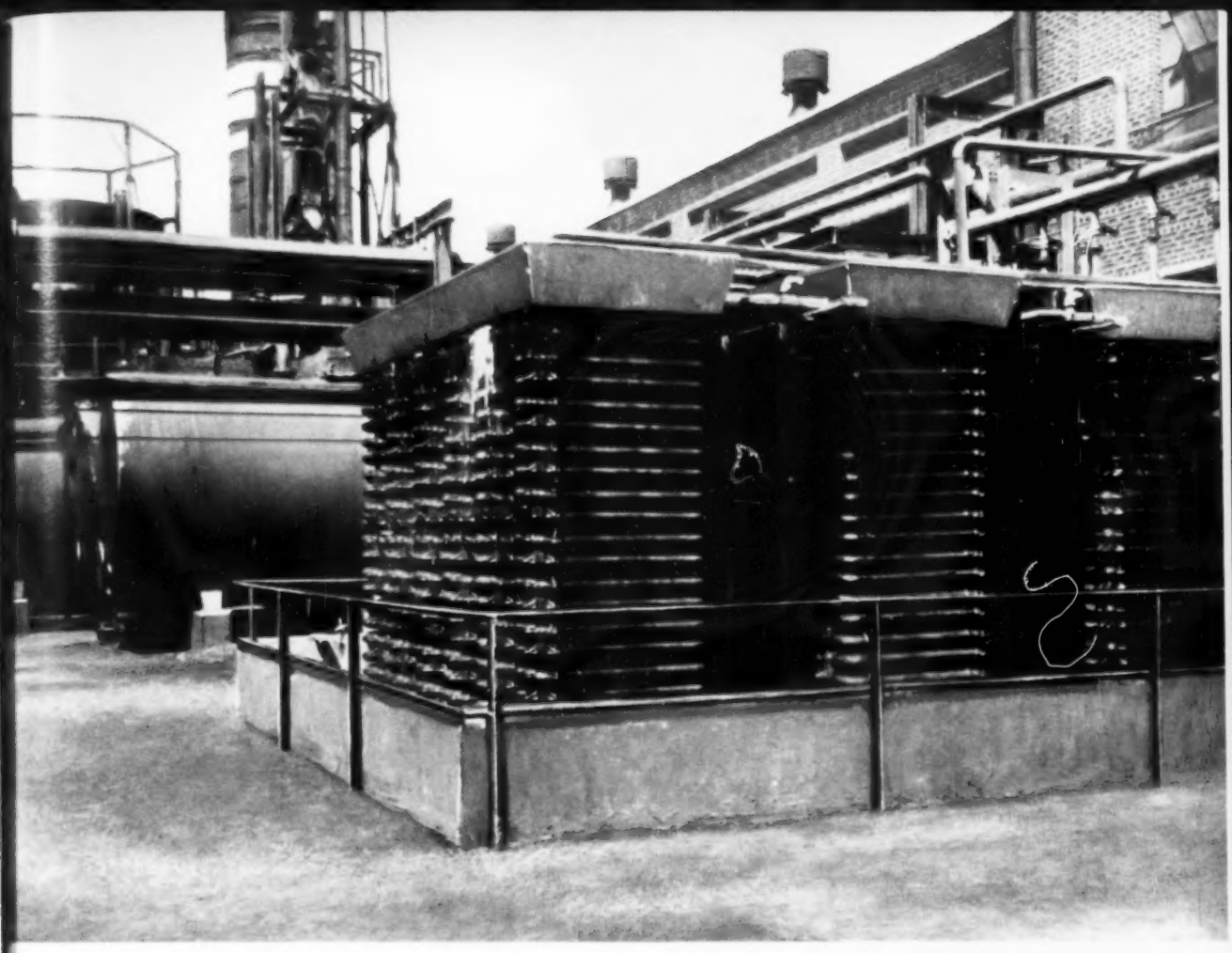
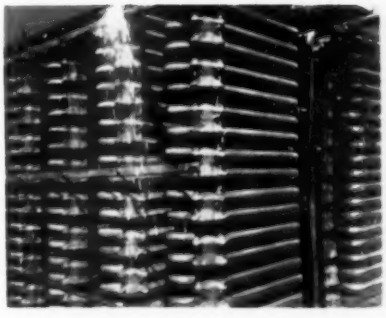
L. R. McCann and Robert Chuse



NALCO blue

that signals CORROSION PREVENTION



Nalco blue on these exposed cooling unit coils is the visible evidence of effective corrosion prevention at work. Nalco System chemicals used in this installation form a tough protective film of characteristic blue color on all ferrous metal surfaces. The metal is literally sealed off from direct contact with water, air and fumes, yet the film itself will not impair heat transfer efficiency.

Similar Nalco protection for your plant can cut maintenance costs and protect you against unscheduled shutdowns that are frequently caused by damaging corrosion. Call your Nalco Representative for some facts and figures on Nalco System protection and economy.

NATIONAL ALUMINATE CORPORATION

6208 West 66th Place Chicago 38, Illinois

Telephone: POrtsmouth 7-7240

CANADA: Alchem Limited, Burlington, Ontario
NORTHWESTERN UNITED STATES, HAWAII AND ALASKA:
The Flox Company, Inc., Minneapolis 3, Minnesota
ITALY: Nalco Italiana, S.p.A.
WEST GERMANY: Deutsche Nalco-Chemie GmbH
SPAIN: Nalco Espanola, S.A.

THE *nalco*® SYSTEM . . . Serving Industry through Practical Applied Science

F. J. Tompkins, Chief Design Engineer (right), Bernard Anik, Mechanical Engineer (left rear), Singmaster & Breyer, N. Y. C. Foreground, Michael De Piano, Cooper Alloy Corp.

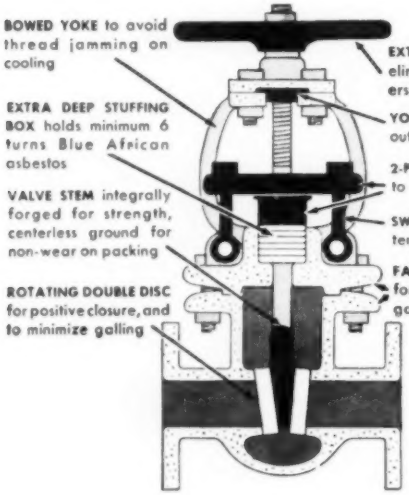
TOMPKINS and ANIK of SINGMASTER & BREYER

tell why they build Cooper Alloy stainless valves into their basic plant designs

Q. Gentlemen, precisely why do you buy Cooper Alloy valves?

FJT—With me, dependability is the main reason. My major concern is overall plant design, and frankly I don't have time to worry about every equipment detail. As specialists in designing and building "first-of-its-kind" processing plants, we need valves we can count on, and can "build in" as part of our original design. Cooper Alloy valves, we've found, fill that bill.

BA—From my point of view as a mechanical engineer, it's the Cooper Alloy valve *design* that appeals to *me*. It has extra features, like the extra-large handwheel, unique square compression of packing, bowed yoke, integrally forged stem, and others, all of which make for less maintenance and longer, more economical valve life.


BOWED YOKE to avoid thread jamming on cooling
EXTRA DEEP STUFFING BOX holds minimum 6 turns Blue African asbestos
VALVE STEM integrally forged for strength, centerless ground for non-wear on packing
ROTATING DOUBLE DISC for positive closure, and to minimize galling
EXTRA LARGE HANDWHEEL to eliminate need for "persuaders"
YOKE NUT REPLACEABLE without valve disassembly
2-PC. GLAND CONSTRUCTION to prevent scoring of stem
SWINGING EYEBOLTS for maintenance convenience
FAIRED BODY-BONNET FLANGES for equal stress and uniform gasket loading

A VALVE DESIGNED FOR STAINLESS!

The Cooper Alloy valve is not an adaptation of earlier brass and iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast in stainless!* **Check the Special Design Features shown at left.**

As the little CA man below is saying: "*You can tell a Cooper Alloy Valve as far as you can see it!*" Write today for *your* copy of our folder "Design Factors In Stainless Steel Valves." The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves *and fittings*, and their advantages. He can serve you promptly from local stocks.

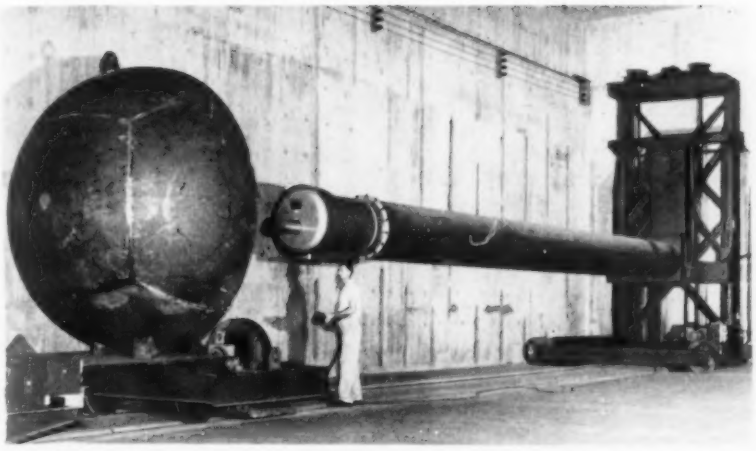
COOPER ALLOY

Corporation • Hillside, New Jersey

VALVE & FITTING DIVISION

THIRTY-FIVE YEARS OF STAINLESS STEEL PIONEERING

 (To obtain more data on advertised products see page 222)



HIGH-VOLTAGE RADIOGRAPHY at Chicago Bridge & Iron Co.'s Birmingham, Ala., plant. A 1-million-volt X-ray machine inspects a pressure vessel head fabricated in the shop. Instrument is fixed on the end of a 43-ft-long, counterweighted boom and is housed in an extra thick concrete structure. Company also uses X-ray to inspect welded shell seams in heavy wall pressure vessels.

Three-way merger in process

A proposal for the acquisition by Union Tank Car Co. of Phoenix Mfg. Co. and its subsidiary, Graver Tank & Mfg. Co. is now being voted on by stockholders of Phoenix. Directors of Union Tank Car and Phoenix have already approved the arrangement.

Graver is the manufacturer of almost all the tank cars used by Phoenix, 60% of which carry petroleum products. Phoenix produces a line of metal and molded rubber products.

Wynkoop Cat Con sales manager

Dr. Raymond Wynkoop has been named manager of sales for Catalytic Construction Co. Wynkoop has been with Publicker Industries, Standard Oil Co. (Ind.), Algonquin Chemical Co., National Distillers & Chemical Co., and Houdry Process Corp., parent of Catalytic.

He took an undergraduate degree at Worcester Polytechnic Institute and received his doctorate at Princeton.

New supplier of furfural

Cumberland Corp., a new firm that makes charcoal briquets for the consumer market, plans to enter commercial production of furfural after expansion of its Burnside, Ky., plant at some future date.

Cumberland would make the chemical from hardwood timber and sawmill wastes, raw materials considered good alternatives for oat hulls, cotton seed hulls, rice hulls, and corn cobs. A process for extracting furfural from hardwood wastes has been patented by Dr. Eduard Farber, of Timber Engineering Co., and is assigned to Cumberland.

President of Cumberland is Thomas N. Peck, and administrative offices are in Bell House, Lexington, Ky.

UCC plans technical service lab

Union Carbide Chemicals Co. expects to build a technical service laboratory on its property near Tarrytown, N. Y. Facilities will be installed to assist customers in 24 major industries. There will be 63 individual laboratory units and complete analytical facilities with provision for tracer chemistry. The lab will be built on a 280-acre site, and completion is expected by 1959.

Lukens steps up research

Lukens Steel Co. has begun an intensive research program to improve its standing as a supplier of alloy and alloy-clad steel plates to the petroleum industry. Within the past year Lukens has more than doubled its manpower in the research department and nearly doubled its technical service staff, according to John H. Faunce, Jr., director of market and commercial development. Company also is well along with construction of a new physical test laboratory.

Future research, Mr. Faunce said, will be especially heavy in alloy steels for high-temperature service and in improving their qualities for field-welding; graphitization problems; and hydrogen attack and embrittlement.

K-C makes Catforming catalyst

Kali-Chemie A. G., a chemical firm at Hanover, Germany, recently began production of catalyst for the Atlantic Refining Co.'s Catforming process. Facilities were built for the purpose. In addition, Kali-Chemie is the only firm besides Socony Mobil Oil Co. at Paulsboro licensed to make Socony's TCC cracking catalyst.

Blaw-Knox ups Coats, Mitchell

Dr. Hal B. Coats, with Blaw-Knox Co. for 15 years, has been made assistant manager of the Chemical Plants Div. Dr. Coats holds a B.Ch.E. an M.S. and a Ph.D. from the U. of Michigan. He has served as research and development director of the Chemical Plants Div. and manager of its atomic energy department.

Dr. Coats

Robert A. Mitchell is the new chief engineer of Blaw-Knox's midwest headquarters in Chicago. A chemical engineer, Mr. Mitchell graduated from the U. of Alabama in 1936, and joined Kendall Refining Co. After service in the Army's Chemical Warfare branches, he went to American Cyanamid, and in 1951, joined Blaw-Knox.

Mr. Woolman

Mr. Burns

Oakite appoints, reassigns

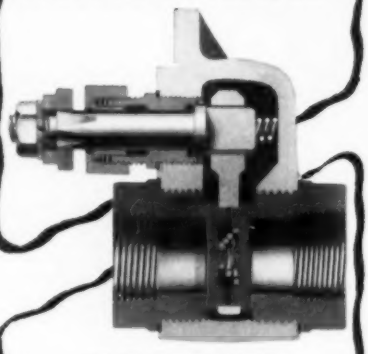
Oakite Products, Inc., has appointed Wilfrid A. Woolman, formerly with Cities Service's Lake Charles refinery, technical service representative in Beaumont, Texas. Francis J. Burns has

FULL-FLOW

Okadee

VALVES

NON-LUBRICATED



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FOR

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- Propane
- Styrene
- Butadiene
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- Jet Fuels

Available in Stainless Steel or Steel, Chemically Nickel Coated

You can select Okadee Valves for flow by pipe size—and get full-flow and positive shut-off with virtually any liquids and gases.

Quick-opening, metal-to-metal disc valves and seats require no lubrication—virtually no maintenance for hundreds of thousands of operations . . . Real valve *performance* and *service*.

FACTS AND FIGURES

. . . on Okadee Valves will be sent promptly on request. Sizes ½" to 8"; A.S.A. dimensions; screwed or flanged. Valve seats and discs Stellite or stainless steel; your choice of operators.

- Write for Bulletin CP6

Okadee COMPANY

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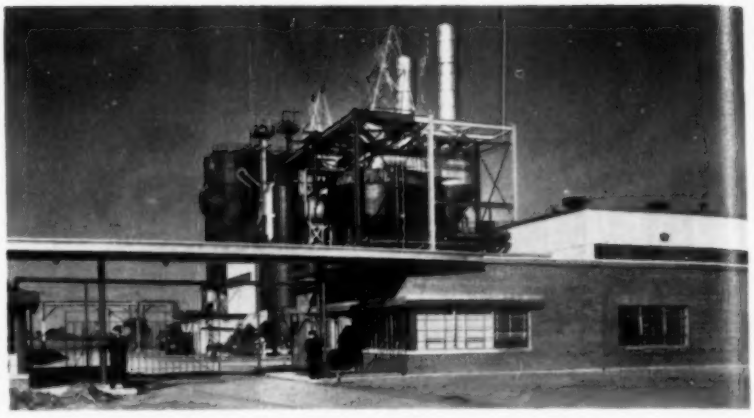
CHICAGO 4, ILLINOIS



A NEW CANADIAN CATALYST PLANT is in full production near Quebec. The $6-million installation of Davison Chemical Co., Ltd., which produces synthetic fluid cat cracking catalyst, is supplied with sodium silicate from an adjacent plant built for the purpose. Locally produced sulfuric acid is also used by the Valleyfield installation.

been named to the same post in the Billings area. He succeeds R. W. Krajicek, who has been transferred to Lake Charles.

Also newly assigned are Donald O. Mundale, who moves to Marion, Ohio from Asheville, N. C., and James E. Davenport, who will provide technical service in Rocky Mount, N. C.

Casselman is S&W chief engineer

Stone & Webster has made Theodore E. Casselman chief chemical engineer. Before joining the company in 1935 as a project engineer, Casselman was with Worthington Corp., Jackson Engineering Co., and the American Locomotive Co. He holds a degree in mechanical engineering from M.I.T.

Mr. Casselman

The Houston district manager, Robert J. Carter, has been named special assistant to the managing director of E. B. Badger & Sons Ltd., a Stone & Webster subsidiary. Carter began with the firm in 1939 and had worked on a British Petroleum Chemicals project in Scotland in 1949 and 1950. He holds a mechanical engineering degree from Washington University.

Top level promotions at SD

Thomas P. Brown and Walter N. Alexander have been appointed to the newly created positions of senior vice-president at Scientific Design Co. Brown, formerly vice-president of new projects, will coordinate research, development, sales and legal activities of the firm. He was once a vice-president of Reichhold Chemicals, Inc.

Alexander will coordinate engineering, construction, and operation activities. He remains executive vice-president of SD Plants, construction subsidiary. Previously Alexander worked with General Aniline & Film Corp.

Promoted to vice-president from assistant vice-president were Henry F. Peters, David Brown, and Philip E. Newman. Peters, who was at one time with Du Pont and M. W. Kellogg, is vice-president of engineering. Brown, previously with Standard Oil Co. of California, M. W. Kellogg, and Shell Development Co., has been assigned to research and development. Newman, at one time with Pechiney and Hercules Powder Co., is vice-president of European affairs.

Further advancements were:

Paul S. Monroe, former director of engineering to assistant vice-president and director of general engineering.

Gregory F. Vinci, from project engineer to director of the operating department.

Russell G. Hill, from project engineer to technical assistant to the vice-president for engineering.

Dr. John H. Lutz, from project engineer to administrative assistant to the engineering vice-president.

John W. Colton, to director of process development.

Dr. Robert S. Davis, to director of engineering development.

Robert W. Simon to assistant to the vice-president for European affairs.

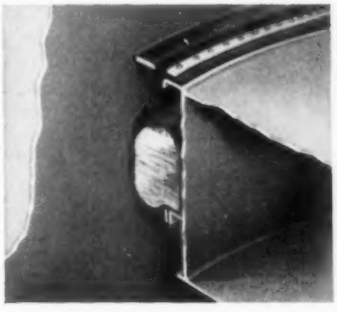
Continued on p. 200

every oil operator wants to know

HOW TO PREVENT LIGHTNING FIRES IN TANKS

the answer is now available

USE HAMMOND TUBESEAL* FLOATING ROOFS!

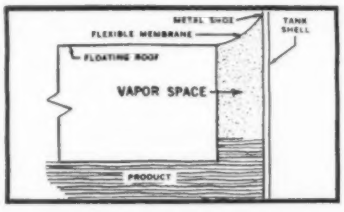


TUBESEALS are made lightning-proof with their exclusive electric conductor weather seal.[1] This specially compounded synthetic rubber, extending continuously around the entire perimeter, between roof and tank shell, provides an infinite number of contact points. ELABORATE TESTING by an independent laboratory[2] discloses that the seal prevents isolation and collection of static electricity charges, providing a continuous conductive surface with large current carrying capacity. Induced charges from lightning are immediately dissipated and fires are prevented. There are no mechanical contacts to cause sparking.

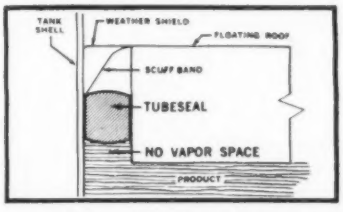
WITHOUT VAPOR THERE CAN BE NO FIRES. . . the inherent design and construction of Hammond Tubeseals eliminates space between roof, shell, and liquid; thus, there is no room for vapor to form . . . no vapor . . . no fires . . . no evaporation . . . no corrosion!

Introduced to the oil industry late in 1955, the Hammond Tubeseal found immediate favor with oil companies all over the world . . . there are now more than 200 installations in operation and building. A measure of their conservation values and fireproof features is illustrated by their record of repeat orders from satisfied users—one large oil company, after several test installations, re-ordered more than a score of Tubeseals. The same story of satisfaction exists wherever a Tubeseal is in operation.

Write for bulletin TS



CONVENTIONAL FLOATING ROOF tank has space below flexible membrane where air-vapor mixtures form. Because metal shoe and membrane cannot be absolutely gas tight, vapor is constantly escaping. This condition causes excessive corrosion, may also result in rim fires from lightning or other source.



HAMMOND TUBESEAL FLOATING ROOF entirely eliminates every space where air-vapor mixtures can form. Hammond Tubeseal completely fills space between product surface and roof seal, so that corrosion is stopped (even for sour crudes), and vapor cannot form—hence cannot ignite or be lost.

THE HAMMOND TUBESEAL
for new or old floating roof tanks,

FEATURES

- **lightning and fire proof construction**
- **no moving parts**
- **no mechanical maintenance**
- **climate-proof**
- **non-corrodible**
- **can operate to bottom of tank or above the top**
- **no vapor space below the seal**
- **entire circumference has tight seal under pressure at all times**
- **longer working life expectancy**

*Patented [1]patent pending [2]names on request

HAMMOND TUBESEAL — THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH • CASPER, WYO. • BIRMINGHAM, ALA.

Sales Offices:

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TUBE FITTINGS

first in engineered precision

• Swagelok tube fittings provide an easily-installed, torque-free, leak-proof seal. There is a Swagelok Specialist in your area. Write Dept. D7.

CRAWFORD FITTING COMPANY
884 East 140th Street • Cleveland 10, Ohio

Suppliers (continued)

Dr. Robert B. Egbert, formerly vice-president of engineering, has resigned and sold back his interest in the company. He remains as a special consultant.

Mr. Somerville

Mr. Widman

McKee names construction mgr.

A. E. Somerville has been appointed manager of construction operations at Arthur McKee & Co. He succeeds the late J. H. Sharpe. R. G. Widman has been appointed assistant construction manager. He joined the company in 1948 after graduation from the University of Michigan.

New addresses

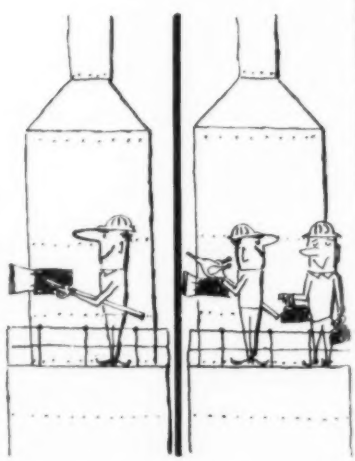
Ever-Tite Coupling Co. Inc. has opened a midwestern sales office at Suite 2107, Carew Tower, Cincinnati 2, Ohio. Telephone number is Dunbar 1-4441.

Blaw-Knox Co. has opened its eastern regional office at Black Horse Pike and High Street, Haddon Heights, N. J. Telephone number is Lincoln 7-3500.

Manning, Maxwell & Moore has opened a new office and warehouse in Bellwood, a suburb of Chicago.

Clark Bros. Co. has opened a new office and warehouse at 800 Central Expressway, New Orleans, La.

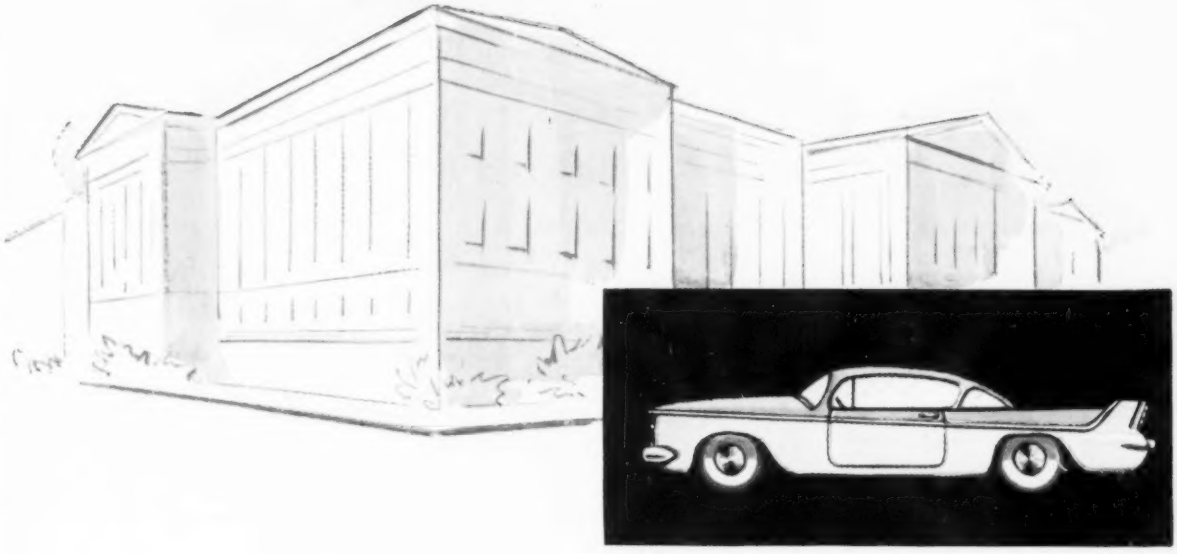
• • •



New patents

foreshadow still greater use of

Ba additives



Of all patents issued in 1956 for metallic detergent and dispersant additives, five out of six were for barium-based compounds.

Westvaco is keeping well ahead of the rapidly rising demand and will continue in the years ahead to fulfill its responsibilities as the leading supplier of barium chemicals. By increasing our productive capacity and mineral reserves, and by research to develop useful new forms of barium, we constantly anticipate the needs of all users.

For information about Westvaco Barium Chemicals, write for our interesting 24-page booklet.

BARIUM OXIDE
BARIUM OCTAHYDRATE
(Flake and Crystal)
BARIUM PENTAHYDRATE
(Flake)
BARIUM NITRATE
BARIUM PEROXIDE
BARIUM CARBONATE*
BARIUM SULFIDE

*Western Delivery only

fmc®
chemicals

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FOOD MACHINERY AND CHEMICAL CORPORATION

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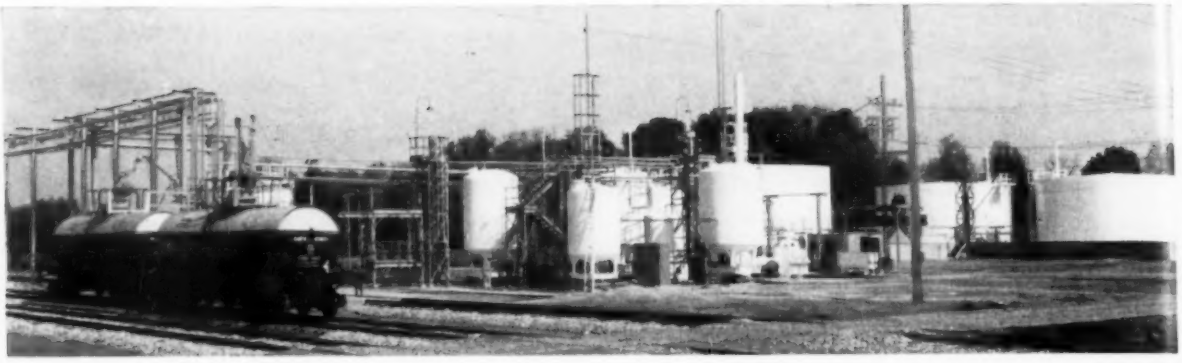
BECCO® peroxygen chemicals • FAIRFIELD® pesticide compounds • FMC® organic chemicals • NIAGARA® insecticides, fungicides and industrial sulphur • OHIO-APEX® plasticizers and resins • WESTVACO® alkalis, solvents, phosphates, barium and magnesium chemicals

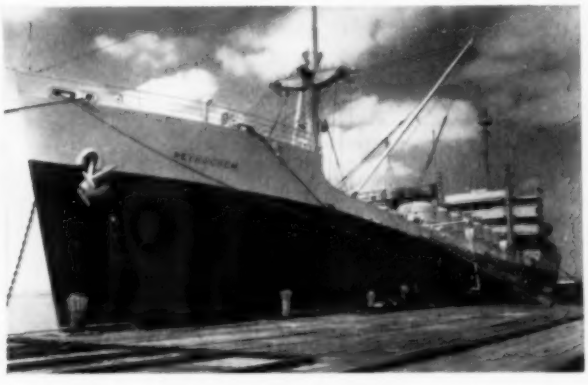


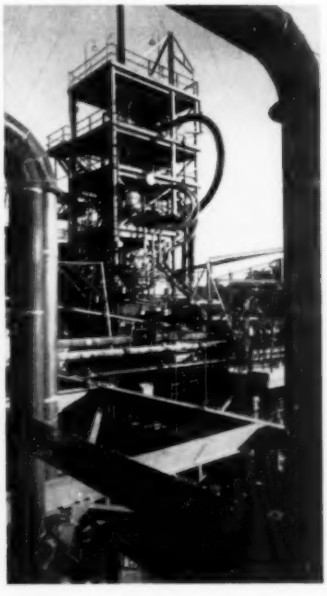
HERE IS the new Du Pont tetraethyl lead terminal at Beaumont, Texas. This latest addition to the rapidly expanding facilities insures an ample nearby supply, and prompt filling of orders from Gulf Coast refiners. The terminal contains complete modern equipment for storage and handling, and rapid dispatch of loaded TEL tank cars. The new terminal will be kept amply supplied with TEL by tank ship from the Du Pont manufacturing plant at Deepwater, New Jersey.

Three major expansions of Du Pont TEL facilities—already completed in 1957

Already this year Du Pont has opened a large new storage terminal, commissioned a new ship and opened a new manufacturing plant.

MV PETROCHEM, first ship to transport TEL compound in bulk, is another major addition to Du Pont's setup for delivering tetraethyl lead. Built primarily to supply the Beaumont TEL terminal, she is also equipped for transporting ethyl chloride and ethylene dichloride on northbound sailings. For maximum safety, the 6,000-ton tank ship is permanently compartmented, with solid bulkheads dividing the operational and cargo sections.





THIS NEW DU PONT TEL manufacturing plant at Antioch, California, was completed by Du Pont early this year. It was constructed to meet the needs of the fast-growing West Coast refining industry. Incorporating the most modern TEL manufacturing facilities in the world, it makes possible fast, short-distance shipments of California-made TEL to all West Coast refineries.

THESE THREE major expansions will increase even more the efficiency of the nationwide network of Du Pont TEL facilities. They complement the Chambers Works TEL manufacturing plant, the Du Pont Petroleum Laboratory, the five regional Petroleum Chemicals laboratories, the conveniently located rail sidings with loaded tank cars in 14 major refining areas, and the 12 sales-service offices. Like the wide range of services—technical, marketing, research, safety and operational—offered by Du Pont, the purpose of these installations is to help you get the most out of our additives program.

DU PONT
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Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & CO. (INC.) · Petroleum Chemicals Division · Wilmington 98, Delaware

By ROBERT L. DAVIDSON, Associate Editor

New Isomerization Process

. . . *uses low pressures for high conversion*

A NEW process, and platinum-alumina catalyst, for the catalytic isomerization of n-butane and n-pentane, are described by Houdry Process Corp. in U.S. Patent 2,798,105.

Advantages cited for the process are high conversions and good selectivity at relatively low operating pressures. Excellent conversion and selectivity result for isomerization of n-pentane at 725-850°F, 50-200 psig, 0.5-2 mol ratio of hydrogen to hydrocarbon, and 4 v/v/hr space velocity.

Small amounts of chloride or other halogen ion are recommended in the catalyst to suppress catalytic cracking and hydrocracking, and to increase isomerization selectivity and conversion.

Optimum conversion is reported (about 60-64% total conversion) at about 800°F, 100 psig, and 4 v/v/hr. Examples cited in the patent are for isomerization of feedstocks composed of technical grade n-pentane, 42 vol% n-pentane mixed with East Texas naphtha, 98% n-pentane mixed with East Texas naphtha, and n-butane.

In the case of n-pentane alone, conversion was 60.7% and isomerization selectivity 94.5%. When the n-pentane was diluted with a large amount of naphtha, conversion dropped sharply. However, when the dilution was only slight (98 vol% n-pentane) conversion dropped only a few points, from 63% down to 58% (compared with technical grade n-pentane), and selectivity dropped from 84% to 81% —these still being attractive commercially. Isomerization of n-butane gave a 93% of theoretical yield (33.4% per pass) with a selectivity to isobutane of 88%.

THE FOLLOWING PATENTS are selected from the Official Gazette of the U. S. Patent Office for June 25, Vol. 719, No. 4; and July 2, 9, 16, Vol. 720, Nos. 1,2,3. Copies of patents are available for 25¢ each. Order by patent number from the Commissioner of Patents, Washington, D. C.

Processes and methods

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Activation	chemical reactions	spark discharge	The Texas Co.	2,799,640
Adsorption	liquids	moving granular solids	Union Oil Co. of Calif	2,796,947
Catalytic cracking	hydrocarbon oils	fluidized cat. system	Shell Development Co.	2,798,795
Catalytic reforming	light oils	phosphomolybdic acid cat.	M. W. Kellogg Co.	2,799,624
Concentration	aromatics	cat. react. of unsaturates	Universal Oil Products Co.	2,799,627
Condensation	hydrocarbons	carbohydrates	Universal Oil Products Co.	2,798,098
Contacting	gas-fluid solids	fluidized contact bed	Esso Research & Engrg. Co.	2,799,095
	gas-solids	cyclic method & granular solids	M. W. Kellogg Co.	2,799,359
Conversion	hydrocarbons	fluidized cat. bed	Phillips Petroleum Co.	2,798,030
	liq. hydrocarbons	moving contact material	Socony Mobil Oil Co., Inc.	2,799,625
	liquids to gases	granular contact material	Socony Mobil Oil Co., Inc.	2,798,029
	residual oils	fluidized solids bed	M. W. Kellogg Co.	2,799,626
Degasification	non-gaseous fluids	cylindrical vessel	Esso Research & Engrg. Co.	2,798,573
Dewaxing	cylindar oil stock	urea treatment	Ashland Oil & Refining Co.	2,799,623
	mineral oils	filtering additives	Esso Standard Societe Anon. Francaise	2,798,027
Distillation	liquids	increased flash vap. depth	Phillips Petroleum Co.	2,799,628
Drying	NH_4NO_3 prills	gas-cooled prilling tower	Phillips Petroleum Co.	2,798,301
Inhibition	exaporation	floating layer	Standard Oil Co. (Ohio)	2,797,138-41
Isomerization	n-butane & n-pentane	Platinum-containing cat.	Houdry Process Corp.	2,798,105
Manufacture	acetophenone	xylene & ethylbenzene	Universal Oil Products Co.	2,797,245
	acrylonitrile	HCN-acetylene reaction	American Cyanamid Co.	2,798,035
	acrylonitrile	reaction of HCN & acetylene	American Cyanamid Co.	2,798,883-4
	alcohols & ethers	hydration of olefins	Sinclair Refining Co.	2,797,247
	alcohols & ethers	propane-propylene oxid.	Sinclair Refining Co.	2,798,097
	ammonia	automatic-control compressors	Chemical Construction Corp.	2,799,562
	ammonium phosphate	H_3PO_4-NH_3-H_2O plus recycle	Union Oil Co. of Calif.	2,799,569
	aromatics	cat. reaction of olefins	Shell Development Co.	2,798,889-90
	aq. suspensions	synthetic elastomer	Esso Research & Engrg. Co.	2,799,662
	benzene hexachloride	cat. additive chlorination	Columbia-Southern Chemical Corp.	2,797,195
	catalysts	molybdenum on a support	Universal Oil Products Co.	2,799,661
	catalysts	platinum on adsorptive support	Universal Oil Products Co.	2,798,051
	cracking cat.	silica-alumina comp.	Esso Research & Engrg. Co.	2,798,857
	cumene hydroperoxide	cumene & terephthalic acid	Montecatini	2,799,711
	dieneic polymers	high molecular weights	O. W. Burke, Jr.	2,797,208
	ethylene oxide	direct cat. oxide of ethylene	M. L. Gould & R. Katzen	2,799,687

Patent Listing continued on p. 207

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MAN HOURS ALONE

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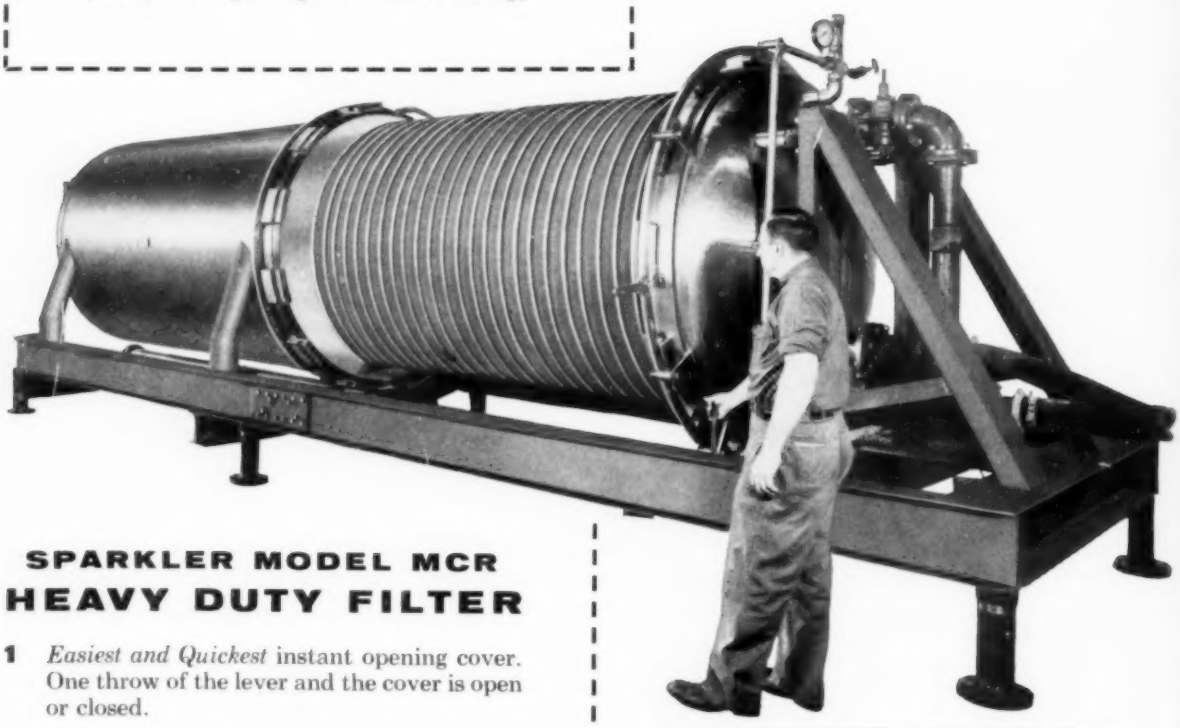
(as reported by a large American Brewery)

Built to handle products with a high percentage of solids, with long operating cycles.

Engineered to lower filtration costs.
Fast cleaning with a minimum of down time.

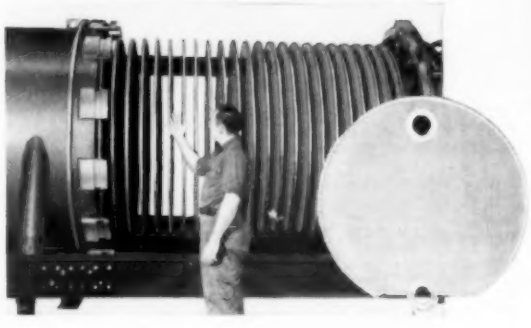
Anyone interested in reliable uniform quality, highest daily volume production, and economical operation, will not be satisfied with anything less than a Sparkler MCR.



SPARKLER MODEL MCR
HEAVY DUTY FILTER

1. *Easiest and Quickest* instant opening cover. One throw of the lever and the cover is open or closed.
2. Retractable tank, hydraulic power operated with finger tip control.
3. No breaking of pipe connections with fixed head. No spillage.
4. Plates spread far apart to allow full size cake without clogging. Large top plate outlet and bottom drainage outlet reduces flow resistance.

Write for complete facts in bulletin



SPARKLER FILTERS

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Mundelein, Illinois

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BUTADIENE FROM BUTANE IN ONE MONEY-SAVING STEP

Texas Butadiene & Chemical Corporation at Houston is on stream with two new Houdry Dehydrogenation Units. They can provide 65,000 tons of butadiene and enough butenes for 2.5 million barrels of light alkylate, or, by recycling, up to 86,000 tons per year of butadiene alone. These units swell the butadiene capacity licensed by Houdry in the past two years to 250,000 annual tons, and re-emphasize the fact that over 50% of all new U.S. butadiene capacity added since 1946 is Houdry designed and licensed.

Look into the remarkable flexibility and economy of the single-step Houdry Dehydrogenation Process, employing the process-proved Houdry Chrome-alumina Catalyst. For information, write to Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

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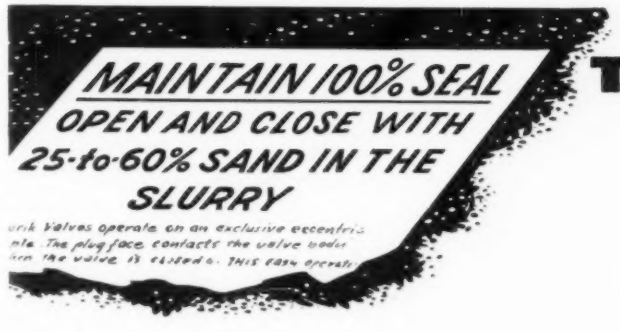
Arsenical Copper • Cupro-Nickel 10%—20%—30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

17SC57

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Manufacture (cont'd)	gasoline additive	partially hydroxylated hydrate of metallic monobasic acid	Ethyl Corp.	2,798,797
	hollow particles	film-forming material	Standard Oil Co. (Ohio)	2,797,201
	hydrocarbon resin	polymerization of dripolene	American Oil Co.	2,798,866-7
	ketones	2,3-epoxybutane & sat'd epoxides	Esso Research & Engrg. Co.	2,799,708
	odorless solvent	fullr's earth treat. of hvy alkylate	Standard Oil Co. (Ohio)	2,799,718
	olefins	simultaneous acetylene recovery	Lummus Co.	2,796,951
	petroleum resins	polym. of cyclopentadiene dimers	Esso Research & Engrg. Co.	2,798,865
	phenol compounds	oxidation	Hercules Powder Co.	2,799,698
	platinum cat.	alumina gel support	Esso Research & Engrg. Co.	2,798,050
	propionic acid	CO_2-alkali metal acetylide	Ethyl Corp.	2,799,703
	synthesis cat.	iron component	Pan American Petroleum Corp.	2,797,200
	urethanes	conv. of polyisocyanates	Farbenfabriken Bayer AG	2,797,232
Production	methyl mercaptan	purification by dist.	American Oil Co.	2,797,191
Purification	acrylonitrile	hydrog. of acetylene cmpds	Montecatini	2,799,630
	aq. formaldehype	ethylene dichloride extraction	Warren Petroleum Corp.	2,799,710
	xylene	removal of ethylbenzene	Union Oil Co. of Calif.	2,798,104
Recovery	aluminum halide	fluid-solids bed zone	Phillips Petroleum Co.	2,797,981
	ammonia	ammonium hydrogen phosphate	DuPont	2,979,148
	fluid cat fines	fluid cat reforming unit	M. W. Kellogg Co.	2,797,189
	methanol	separation from aq. formaldehyde	Allied Chemical & Dye Corp.	2,798,033
	monomeric acrylamide	reaction & neut. process	American Cyanamid Co.	2,798,887
	pigments	isolation from gas	Godfrey L. Cabot, Inc.	2,799,358
	xylenes	extractive distillation	Imperial Chemical Industries Ltd.	2,799,629
Refining	waxes	ketone dewaxing etc.	Esso Research & Engrg. Co.	2,798,028
Removal	gaseous acids	alkanol amine salt soln.	Dow Chemical Co.	2,797,188
Separation	hydrocarbons	cyclic adsorption	Jefferson Lake Sulphur Co.	2,799,360-4
	liquids	solid adsorbent	California Research Corp.	2,797,190
	organic compounds	Werner complex clathrates	Union Oil Co. of Calif.	2,798,891
	solutes in mutual solvent	fractionation system	Food Machinery & Chemical Corp.	2,798,796

Patent Listing continued on p. 208

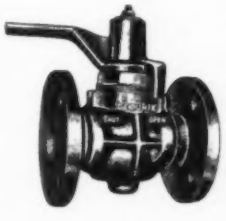


Tough order..?

...not for DeZurik Plug Valves!

DeZurik Plug Valves operate on an exclusive eccentric principle. The plug face contacts the valve body *only* when the valve is closed.

This easy operation and dead tight closure make DeZurik Valves the *right choice* for gasoline and diesel fuel loading racks, bleeder lines from pumping wells, water treater tanks, suction lines to water flood pumps, rotary drilling mud lines and many, many more.



Petroleum installations include some of the toughest services valves can be subject to. And one of the toughest installations in the oil field is on vacuum trucks. Valves must open and close with 25-to-60% sand in the slurry they clean up around the wells . . . and they must maintain 100% dead-tight shut-off!

As a result of a test installation some time ago, a fleet operator standardized on DeZurik Plug Valves for this punishing service. He reports that DeZurik Valves consistently *outlast* and *outperform* any valves he had used. They maintain 100% seal, still open and close easily despite the high sand content, and have an effective life three to four times that of ordinary valves.

DeZurik Valves are available in sizes ½" thru 20", for manual or remote operation and in a wide range of body materials.

For complete details write

DeZURIK CORPORATION
SARTELL, MINNESOTA.

Patents (continued)

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Steam stripping	petroleum oil	stripping column	Gulf Oil Corp.	2,798,031
Sulfonation	benzene	sulfur trioxide & liq. sulfur	Tennessee Corp.	2,798,089
Sweetening	hydrocarbons	air-caustic & Ph, Bi, Tl	Tidewater Oil Co.	2,798,842

Products

Composition	fuel oil	additive	Armour & Co.	2,798,798
Grease	lube oil base	complex metal soap	Esso Research & Engrg. Co.	2,799,656
Inhibition	corrosion of iron	urea & sulfite compounds	California Research Corp.	2,797,199
	foam in oil	detergent & mesityl oxide	Esso Research & Engrg. Co.	2,799,650
	iron corrosion	thiourea-containing compound	The Texas Co.	2,799,648
	metal corrosion	polyalkylene glycol	Esso Research & Engrg. Co.	2,799,649
Lubricant	lube oil	hydrocarbon-sulfide react. prod.	Standard Oil Co. (Ind)	2,799,653
	mineral lube oil	hydrogenated liq. polymer	Esso Research & Engrg. Co.	2,798,853
	mineral lube oil	polymer additive	The Texas Co.	2,799,657
	mineral lube oil	various additives	Shell Development Co.	2,798,045
	oleaginous mat'l	corrosion inhibitor for Ag	Standard Oil Co. (Ind.)	2,799,651-2,654-5
Mixture	polysulfone resin	acrylonitrile or methacrylonitrile	Phillips Petroleum Co.	2,797,205
Motor Fuel	cracked distillate	gum inhibitor	Standard Oil Co. (Ohio)	2,797,152
	hi-octane gasoline	TEL & trialkyl phosphine	Sinclair Refining Co.	2,797,153
Solube oil	mineral lube oil	oil-in-water emulsion properties	Sun Oil Co.	2,797,197
Solution	acetylene	phosphonic acid	Monsanto Chemical Co.	2,799,365

Equipment

Conveyance	Wax cake	plurality of belts	Sun Oil Co.	2,799,384
Measurement	fluid flow	heated by-pass stream	Phillips Petroleum Co.	2,799,165
	viscosity	vertical torsion member	Olin Mathieson Chemical Corp.	2,796,758
Separation	fluids	thermal diffusion apparatus	Standard Oil Co. (Ohio)	2,799,395
	solids in gases	curved-path chamber	Esso Research & Engrg. Co.	2,799,354

REPAIR LEAKS
QUICKLY—PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

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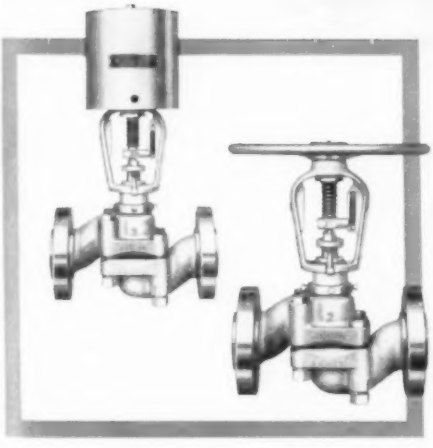

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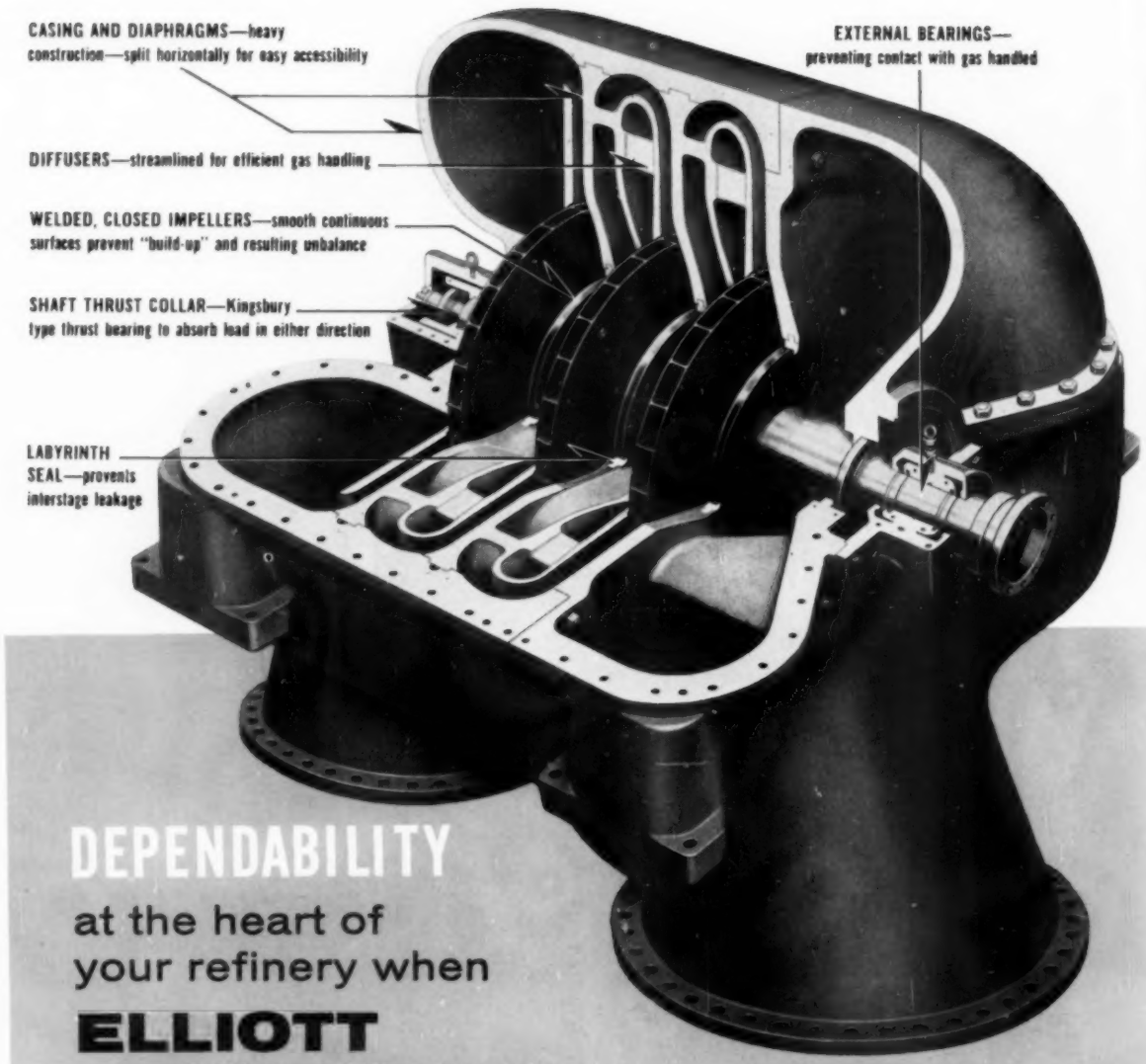
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SHAFT THRUST COLLAR—Kingsbury type thrust bearing to absorb load in either direction
LABYRINTH SEAL—prevents interstage leakage
EXTERNAL BEARINGS—preventing contact with gas handled

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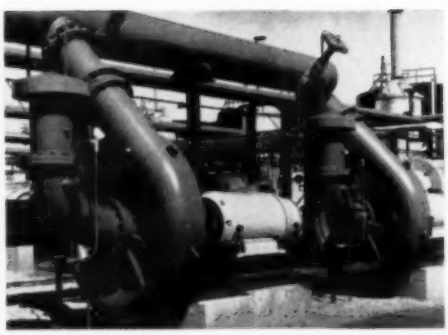

Two of three Elliott motor-driven single-stage centrifugal compressors serving oil black plants in Oklahoma. Each compressor is rated 5255 inlet cfm, handling air at atmospheric pressure and boosting it to 3.85 psig.

Elliott centrifugal compressors are designed and built with the simplicity and ruggedness that pays off in *dependable*, long-term, non-stop performance. Available in single and multistage types . . . for inlet capacities up to 150,000 cfm and pressures up to about 500 psig equivalent air pressure . . . turbine or motor driven . . . with or without step-up gear. For further details, call your nearby Elliott District Office or write Elliott Company, Compressor Department, Jeannette, Pa.

ELLIOTT Company

P7-3

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● The above cutaway illustrates H & B standard jacketed welded pipe and fitting construction, designed to allow complete jacketing of the product pipe. Special jigs and fixtures enable H & B to insure complete uniformity of the jacket area in relation to the O D of the product line and the I D of the jacket pipe. All H & B jacketed equipment is hydrostatically tested at 450 to 500 p.s.i. H & B welded steel jacketed fittings are ideally suited for process piping of pressures reaching 300 p.s.i. and temperatures up to 750°F. . . . A few of these fittings and valves are illustrated below. For more information send for bulletin J-57.

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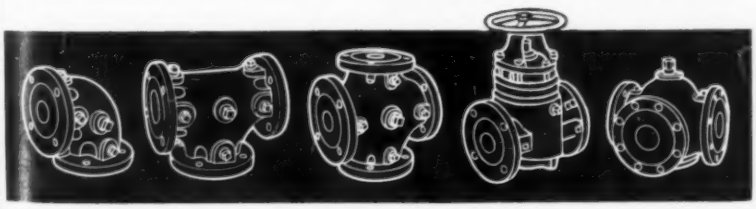

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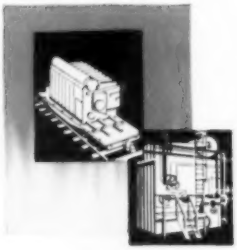
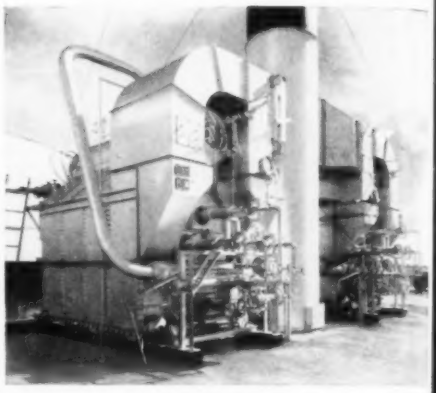


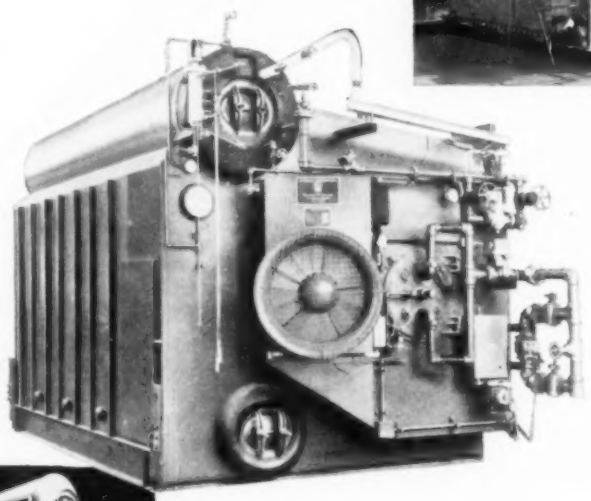
HEAT ENGINEERING by FW

extends Central Station Reliability to Standard INDUSTRIAL and PACKAGED UNITS



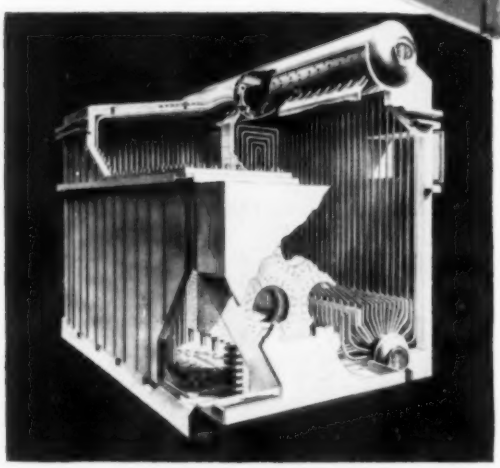
PACKAGED STEAM GENERATORS of the water-tube type were introduced by Foster Wheeler in 1940 — combining in a single, compact, shop-assembled unit, all the necessary facilities for the dependable and economical generation of industrial steam. Continual research and development have resulted in further improvements in design and construction, and today the FW line of Packaged Steam Generators, in capacities from 10,000 to 60,000 lb/hr, represents the last word in modern steam plant design, reflecting over half a century of service to the power generation industry. Features include 36″ steam drum and 24″ water drum, staggered boiler tubes, closely spaced waterwall tubes, water-cooled target wall, and wide choice of burners and controls.

Above: Two FW packaged boilers — the first ever offered to industry — were installed for oil field drilling operations in 1940. They are still in service, delivering low-cost steam.



Left: New Foster Wheeler series AG-100 Packaged Steam Generator.

Cutaway view of typical FW Standard Steam Generator.



STANDARD PRE-ENGINEERED UNITS by Foster Wheeler offer all the advantages and economies of *standardization* for large industrial steam generators of from 50,000 lb/hr to 450,000 lb/hr capacity. The new FW line of "SC" and "SD" standard units is heat engineered to the same standards of dependability and performance which have made Foster Wheeler steam generators first choice in many of the leading central station plants throughout the country. Features include completely water cooled walls, efficient firing arrangement, fully drainable superheater, high steam purity, unrestricted circulation, pressure-tight construction and minimum refractory baffling. For further details send for Bulletin B-55-4.

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

MEETINGS

By STUART D. BOYNTON, Assistant Editor

SAE fuels and lubes program

THE fuels and lubricants meeting of the Society of Automotive Engineers will this year share the spotlight with the transportation and diesel engine divisions of the Society. The meet will be at Cleveland's Hotel Statler, Nov. 6-8. On the fuels and lubes portion of the program, the following are papers of interest to petroleum processors:

"Lubricant Factors Affecting Oil Consumption," by J. K. Patterson, and R. C. Gregor, Esso Research and Engineering Co.

"Series 3 Oils for High-Output Diesel Engines," by J. W. Vollentine, Caterpillar Tractor Co.

"Coking Tendencies of Lube Oils," by F. G. Rounds, General Motors Research Labs.

"Interrelationship of Fuel Constituents, Combustion Chamber Deposits, and Automotive Engine Performance," by A. V. Marstik, R. B. Payne, Sinclair Research Labs.

"Effect of Hydrocarbon Type and Distillation in Boiling Range on Road Anti-knock Performance," by W. Meyer, R. G. Goldthwaite, Gulf Research & Development Co.

"Prediction of Road Octanes in Today's and Tomorrow's Cars," by W. E. Morris, Du Pont Co.

"Many European Cars Downrate Octane Quality," by T. M. Korn, Esso Research & Engineering Co., and E. Potter, Esso Research Ltd.

"Lab Octane Ratings—What Do They Mean," by H. F. Hostetler and R. B. Fell, Standard Oil Co. (Ohio)

From the diesel engine session here is a paper that should interest oilmen:

"Engine Test for Military Lubes—Adequate Test or Beauty Contest?" by H. F. King, U. S. Bureau of Ships, and L. G. Schneider, U.S. Naval Engineering Experiment Station.

Corrosion in refineries an NACE topic in Chicago

High temperature hydrogen sulfide corrosion of stainless steels in petroleum refineries will be one of four topics in a symposium on oil refinery corrosion at the National Association of Corrosion Engineers' meeting in Chicago's Sherman Hotel, October 1-4. There will also be a round table discussion on cathodic protection and three educational lectures.

Other symposia scheduled: protective coatings, water treating, pipe lines, chemical processing, cathodic protection, transportation, and public utilities.

Papers in the coating symposium will cover methods of classifying coatings, chemical preparation of metal

Oil Man's Calendar

Boldface items reviewed in this issue

SEPTEMBER

15-18 American Institute of Chemical Engineers, national meeting, Lord Baltimore Hotel, Baltimore, Md.
22-24 Independent Oil Compounders Assn., annual, Carter Hotel, Cleveland
23-25 Petroleum Mechanical Conference, ASME, Mayo Hotel, Tulsa, Okla.
23-25 American Society of Mechanical Engineers, fall meeting, Statler Hotel, Hartford, Conn.
23-28 Review of low and high-temperature distillation, Podbielniak Institute, 341 E. Ohio St., Chicago
26-27 Western Petroleum Refiners Assn., Rocky Mountain regional technical-industrial relations meeting, Henning Hotel, Casper, Wyo.
30-Oct. 12 Review of vapor-phase chromatographic techniques, Podbielniak Institute, 341 E. Ohio St., Chicago

OCTOBER

1-4 National Assn. of Corrosion Engineers, North Central Region meeting, Sherman Hotel, Chicago
1-4 National Assn. of Corrosion Engineers, South Central Region, Oklahoma City, Okla.
6-10 American Society for Testing Materials, Committee D-2, Sheraton Park Hotel, Washington, D.C.
7-9 Lubrication Conference, ASME and the American Society of Lubrication Engineers, Royal York Hotel, Toronto
7-9 American Gas Assn., annual, Kiel Auditorium, St. Louis, Mo.
7-11 American Institute of Electrical Engineers, fall general meeting, Morrison Hotel, Chicago
9-11 Symposium on High Vacuum Technology, Committee on Vacuum Techniques, Hotel Somerset, Boston
10-11 California Natural Gasoline Assn. annual, Huntington-Sheraton Hotel, Pasadena, Calif.
21-23 American Society of Mechanical Engineers, power conference, Americus Hotel, Allentown, Pa.
22 Association of Consulting Chemists and Chemical Engineers, annual, Belmont Plaza Hotel, New York
22 American Institute of Chemical Engineers, New York Section, Hotel Statler, New York
22-24 Western Regional Conference, National Assn. of Corrosion Engineers, Grant Hotel, San Diego, Calif.
23-25 Permian Basin Corrosion Tour, NACE, Odessa, Texas
24-25 Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Garrett Hotel, El Dorado, Ark.
22 Natural Gasoline Assn. of America Southern Region meeting, Washington-Youree and Capt. Shreve Hotels, Shreveport, La.
28-29 National Lubricating Grease Institute, annual, Edgewater Beach Hotel, Chicago
28-31 American Nuclear Society, winter meeting, Henry Hudson Hotel, New York
28-31 Atomic Industrial Forum, annual, New York

NOVEMBER

3-8 Society for Nondestructive Testing, international conference, Morrison Hotel, Chicago
6-8 Society of Automotive Engineers, fuels and lubes meeting, Hotel Statler, Cleveland
11-14 American Petroleum Institute, annual, Conrad Hilton Hotel, Chicago
12-14 National Assn. of Corrosion Engineers, North Central Regional, Penn-Sheraton Hotel, Pittsburgh
22 Natural Gasoline Assn. of America, Panhandle Plains Regional, Herring Hotel, Amarillo, Texas

DECEMBER

1-6 American Society of Mechanical Engineers, annual, Statler, New York
2-6 Exposition of the Chemical Industries, Coliseum, New York
2-14 Review of vapor-phase chromatographic techniques, Podbielniak Institute, 431 E. Ohio St., Chicago
8-11 American Institute of Chemical Engineers, annual, Hilton Hotel, Chicago
26-31 American Assn. for the Advancement of Science, national meeting, Indianapolis, Ind.

JANUARY

2-3 American Chemical Society, Christmas Symposium, Division of Industrial and Engineering Chemistry, Case Institute, Cleveland

FEBRUARY

2-7 American Society for Testing Materials, Committee D-2, Rice Hotel, Houston

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Meetings (continued)

surfaces, coal tar coatings for underground use, cathodic protection and protective coatings, commercial spray equipment.

Jet session at AIChE fall national meeting

A session on jet propulsion will be part of the fall national meeting of the American Institute of Chemical Engineers. The meeting, Sept. 15-18, will be held in the Lord Baltimore Hotel, Baltimore, Md. There will also be sessions on low-temperature processes, drying, direct operating labor costs, and other topics.

These papers are among those in the jet session:

"Turbine and Rocket Fuels—Present and Future," by D. N. Harris, W. S. Little, Jr., Shell Oil Co.

"Introduction to Chemical Engineering of Liquid Rocket Propellants," by J. F. Tormey, Rocketdyne, Inc.

"Technology of Boron Hydrides," by C. J. Major, American Potash and Chemical Corp.

"High-Energy Hydrocarbon Fuels," by J. Happel, C. J. Marsel, New York University.

"Anhydrous Hydrogen Peroxide As a Propellant," by Ralph Bloom, W. J. Brunsvold, Food Machinery & Chemical Co.

The following are papers to be read in the session on direct operating labor costs:

"Management Engineering Analysis of Director Operating Labor Costs in a Chemical Plant," by F. Gropper, Du Pont Co.

"Industrial Engineering Approach to Estimating Director Operating Labor Requirements for Chemical Processes," by T. B. Haines, Dow Chemical Co.

"Production, Capacity, and Work Load Analysis," by R. S. Wobus, Monsanto Chemical Co.

New York AIChE plans all-day symposium, Oct. 22

A four-part program has been planned by the New York Section of the American Institute of Chemical Engineers for its October 22 meeting at the Hotel Statler.

The all-day symposium will begin with a session titled "Cost Estimation—Planning for Profits," to be chaired by E. E. Winne, of W. R. Grace Co.'s Polymer Chemicals Div. Then, E. J. Willey, of Patent and Licensing Corp., will head a session with the title "You, Your Employer and Your Knowledge—Legally Defined."

In the afternoon two sessions are planned: "Control Engineering — A Challenge to Chemical Engineers," headed by Lloyd Slater, of the Foundation for Instrument Education and Research; and "Professional Engineering—Choice or Compulsion?" led by J. Lawrence, of Lawrence, Inc., a consulting firm.

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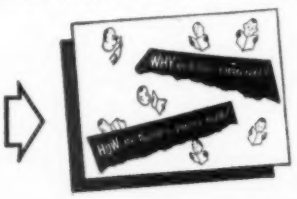

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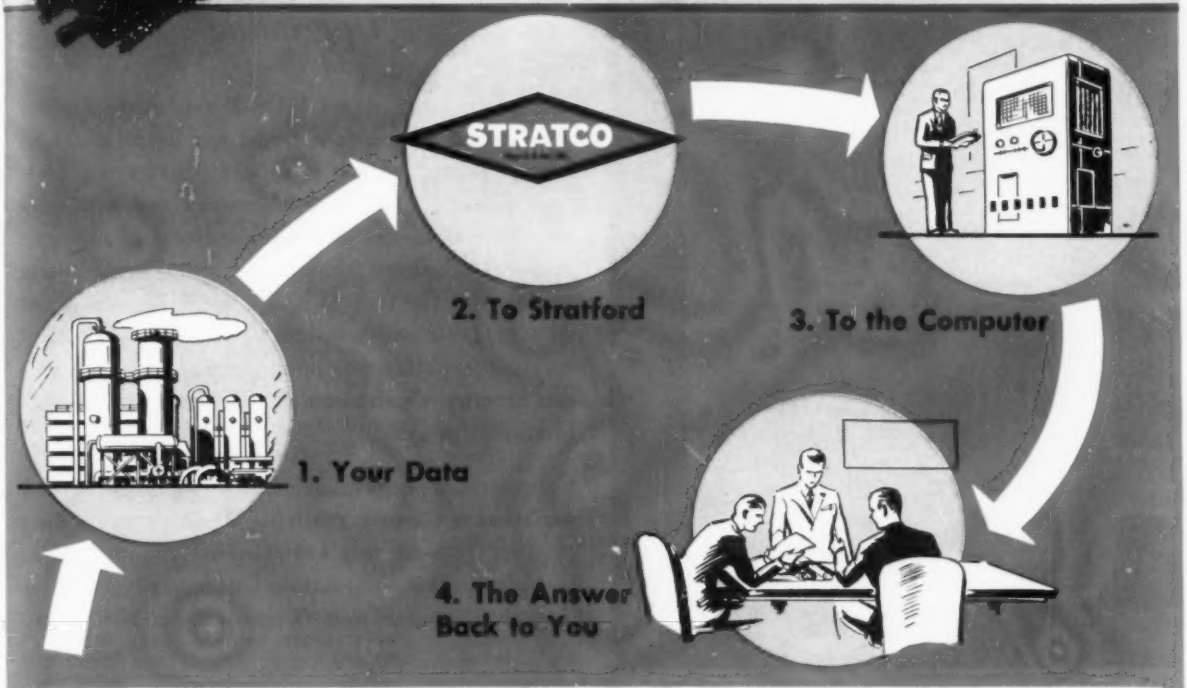

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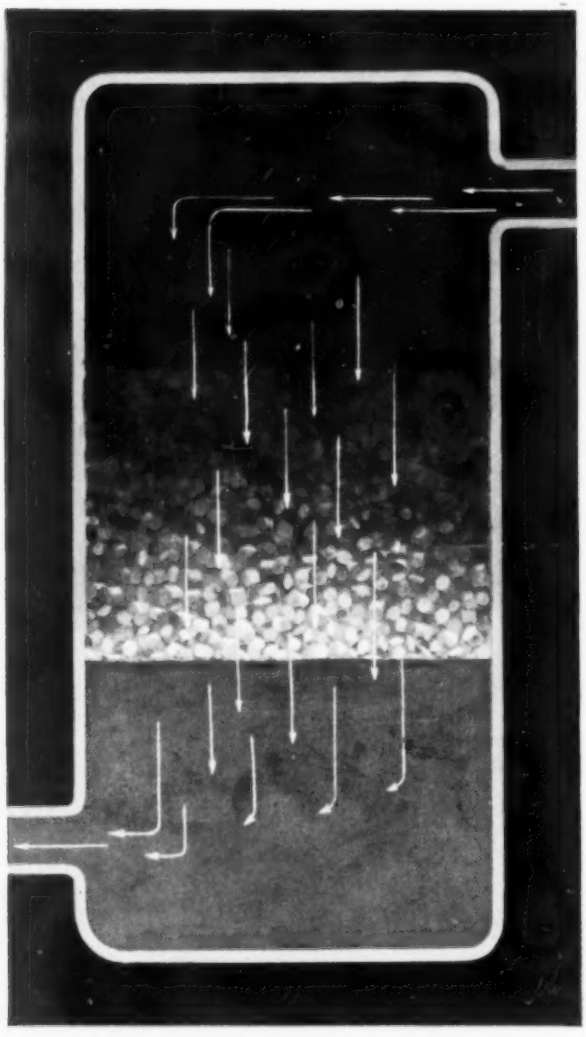

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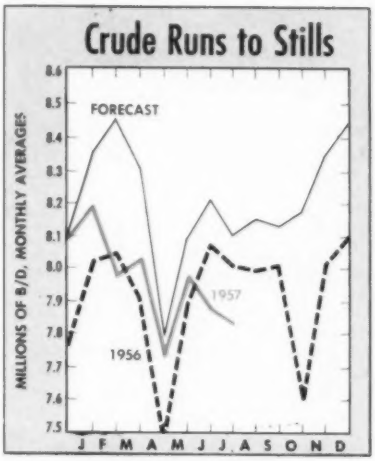
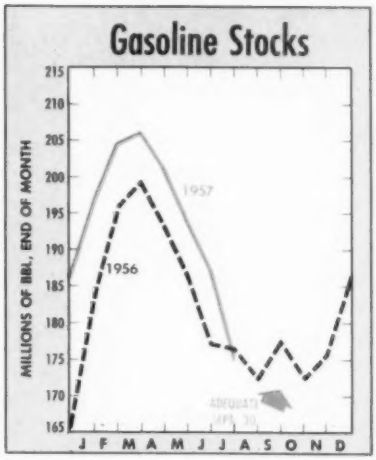
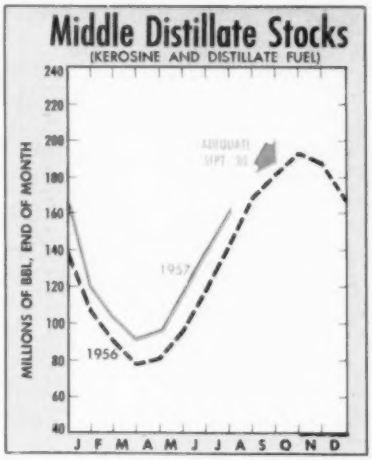
(To obtain more data on advertised products see page 222)

By VIRGIL B. GUTHRIE, Consulting Editor






Middle Distillate Stocks
(KEROSINE AND DISTILLATE FUEL)
MILLIONS OF BBL, END OF MONTH
ADEQUATE SEPT. '56
1957
1956
J F M A M J J A S O N D

Gasoline market is reviving

RESTRAINT in refinery operations this summer, partly due to the closing of plants by strikes, has brought a partial liquidation of the heavy gasoline inventories which hung over the industry last spring. Reduced demand for the distillate fuels, however, keeps these stocks at levels well over the year before. It will take a cold fall and early winter to revive demand for these products sufficiently to bring stocks down to approach a balance with supply and demand.

Through the summer refinery crude runs have averaged around 7,860,000 b/d avg., close to the level of last spring and well above the forecast level of 8,1-8,200,000 b/d avg.

Refinery gasoline stocks in early August broke below the level of the same date a year ago, for the first time since the fall of 1955. On Aug. 9 they were some 14,000,000 bbl under the total of 187,271,000 bbl last Dec. 31. At the end of August, 1956, U. S. inventories were over 7,500,000 bbl higher than at the start of the year.

OUTLOOK: For crude runs to average around 8,000,000 b/d avg. for the fourth quarter.

This trimming of gasoline stocks took place even though gasoline demand was lower than had been anticipated. For the first six months, total motor fuel demand was less than 2% larger than for the same period in 1956, while a gain in demand of around 5% had been forecast.

Oil companies over the country report a pickup in gasoline demand in July, and anticipate fall sales will approach the forecast level of 5%. Overall gasoline demand in July is estimated at 4,279,000 b/d avg, a gain of 6.7% from the actual demand in July, 1956.

While overall distillate fuel oil demand for the first six months was about 5% greater than in 1956, this gain was mainly caused by the large increase in exports due to the emergency shipments to Western Europe. Domestic demand was slightly under that of the year before, the warm winter having held down heating oil sales. Shipments of domestic oil burners and installations of burners so far this year have been under those of the same period in 1956, due to the lower rate of home building and the competition from natural gas.

JULY KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbl at end of month)

	July 1957	June 1957	July 1956
CRUDE OIL			
U. S. Production	6.910	7.244	7.090
Imports	1.172	1.195	1.084
U. S. Stocks	285.241	277.532	277.008
Runs to Stills	7.847	7.891	8.014
GASOLINE			
Refinery Output	3.805	3.909	3.878
Refinery Demand	4.279	4.269	4.010
Primary Stocks	176.171	187.778	176.536
MIDDLE DISTILLATES			
Refinery Output	2.012	2.008	2.063
Refinery Demand	1.271	1.273	1.284
Primary Stocks	168.072	144.632	144.786
RESIDUALS			
Refinery Output	1.096	1.132	1.066
Imports & Other	.409	.484	.346
Total Supply	1.505	1.616	1.412
Refinery Demand	1.384	1.448	1.255
Primary Stocks	48.884	45.115	43.958

PRODUCT AND CRUDE PRICES

Products—¢ gal, weighted average prices in principal refinery markets
Crudes—$ bbl, principal fields
Source—Platt's Oilgram Price Service

	July 1957	June 1957	July 1956
Gasoline (regular)	12.50	12.60	12.13
Distillate Fuel Oil	9.93	10.04	9.33
Kerosine	11.39	11.50	10.92
Residual	6.12	6.31	5.26
Above 4 Products	10.15	10.27	9.59
Lube Oils	24.17	24.17	22.69
Crude	3.18	3.18	2.84

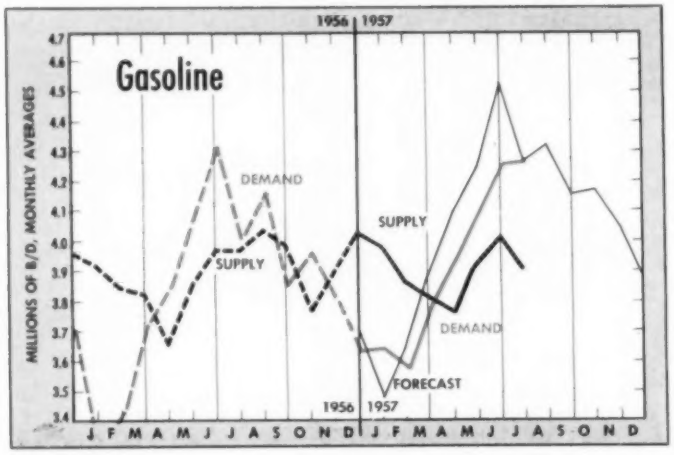
REFINERY YIELDS

% on Crude Run to Stills

	July 1957	June 1957	July 1956
Gasoline	44.1	44.1	44.2
Kerosine	3.3	3.3	3.7
Distillate	22.3	22.1	22.1
Residual	13.9	14.3	13.4

SOURCE OF DATA (except prices): June, July and Aug., API weekly reports; earlier months, Bureau of Mines

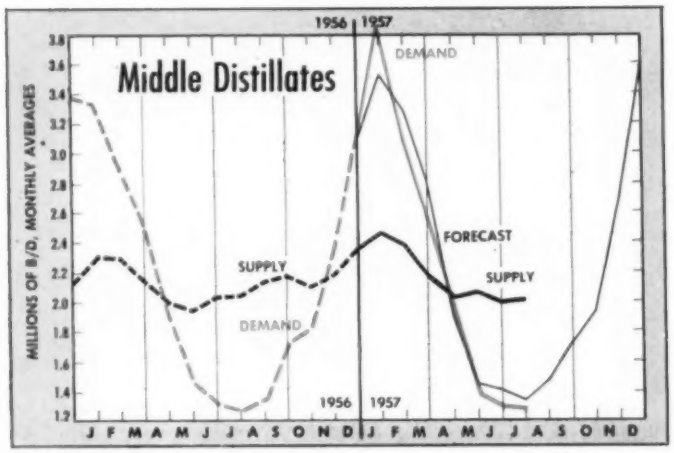
Gasoline demand well ahead of 1956


1956 | 1957
Gasoline
DEMAND
SUPPLY
SUPPLY
DEMAND
FORECAST
1956 | 1957
MILLIONS OF B/D, MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

MOTOR FUEL

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
July '57	3.464	.441	3.905
July '56	3.527	.448	3.975
Change	— .063	— .007	— .070
% Change	— 1.8	— 1.5	— 1.8
DEMAND (including Exports) (Millions of b/d)			
July '57			4.279
July '56			4.010
Change			+ .269
% Change			+ 6.7
TOTAL SUPPLY (Millions of bbl)			
7 Mos. '57	728.336	97.253	826.089
7 Mos. '56	731.069	92.618	823.687
Change	— 2.733	+ 5.135	+ 2.402
% Change	— 0.4	+ 5.5	+ 0.3
TOTAL DEMAND (including Exports) (Millions of bbl)			
7 Mos. '57			838.327
7 Mos. '56			815.812
Change			+ 22.515
% Change			+ 2.8

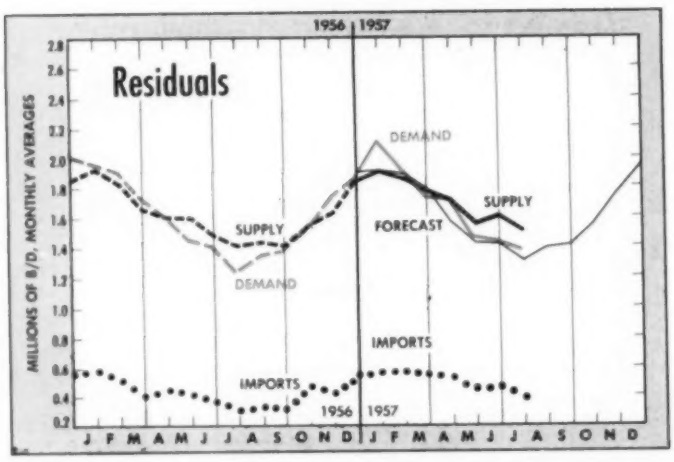
Distillate shipments at seasonal low


1956 | 1957
Middle Distillates
DEMAND
FORECAST
SUPPLY
SUPPLY
DEMAND
1956 | 1957
MILLIONS OF B/D, MONTHLY AVERAGES
J F M A M J J A S O N D J F M A M J J A S O N D

MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
July '57	.260	1.752	2.012
July '56	.296	1.767	2.063
Change	— .036	— .015	— .051
% Change	— 12.2	— 0.8	— 2.5
DEMAND (including Exports) (Millions of b/d)			
July '57	.167	1.104	1.271
July '56	.207	1.077	1.284
Change	— .040	+ .027	— .013
% Change	— 19.3	+ 2.5	— 1.0
TOTAL PRODUCTION (Millions of bbl)			
7 Mos. '57	64.495	395.341	459.836
7 Mos. '56	69.605	381.751	451.356
Change	— 5.110	+ 13.590	+ 8.480
% Change	— 7.3	+ 3.6	+ 1.9
TOTAL DEMAND (including Exports) (Millions of bbl)			
7 Mos. '57	65.042	396.644	461.686
7 Mos. '56	68.531	381.694	450.225
Change	— 3.489	+ 14.950	+ 11.461
% Change	— 5.1	+ 3.9	+ 2.5

Residual supply holds at last year's level



RESIDUAL FUELS

	Refinery Output	Imports & Other	Total
SUPPLY (Millions of b/d)			
July '57	1.096	.409	1.505
July '56	1.066	.346	1.412
Change	+ .030	+ .063	+ .093
% Change	+ 2.8	+ 18.2	+ 6.6
DEMAND (including Exports) (Millions of b/d)			
July '57			1.384
July '56			1.255
Change			+ .129
% Change			+ 10.3
TOTAL SUPPLY (Millions of bbl)			
7 Mos. '57	249.983	112.045	362.028
7 Mos. '56	252.072	100.235	352.307
Change	— 2.089	+ 11.810	+ 9.721
% Change	— 0.8	+ 11.8	+ 2.8
TOTAL DEMAND (including Exports) (Millions of bbl)			
7 Mos. '57			356.603
7 Mos. '56			347.523
Change			+ 9.080
% Change			+ 2.6

SOURCE OF DATA: June, July and Aug., API weekly reports, earlier months, Bureau of Mines (1956 figures for 366 days)

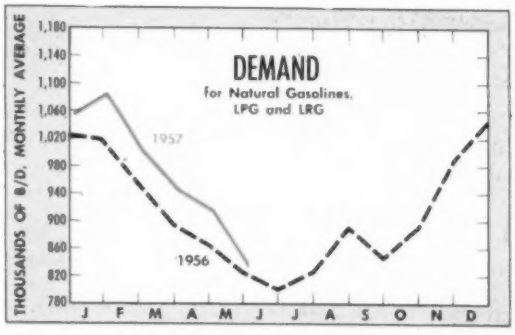
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U.S REFINERY DISTRICTS

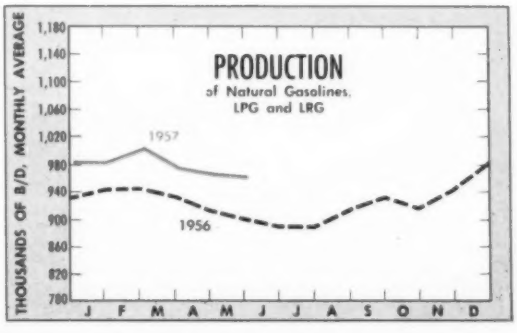
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Aug. 9 1957	Aug. 10 1956	Change	% Change	GASOLINE STOCKS (Millions of bbl on date shown) Aug. 9 1957	Aug. 10 1956	Change	% Change	RESIDUAL STOCKS (Millions of bbl on date shown) Aug. 9 1957	Aug. 10 1956	Change	% Change
East Coast	1.296	1.159	+ .137	+11.8	40.294	41.925	— 1.631	— 3.9	12.660	12.017	+ .643	+ 5.4
Gulf Coast	2.580	2.656	— .076	— 2.9	33.380	34.135	— .755	— 2.2	8.968	8.558	+ .410	+ 4.8
Total Coastal	3.876	3.815	+ .061	+ 1.6	73.674	76.060	— 2.386	— 3.1	21.628	20.575	+ 1.053	+ 5.1
Appalachian	.141	.187	— .046	—24.6	6.891	7.382	— .491	— 6.7	.739	1.092	— .353	—32.3
Ind.-Ill.-Ky.	1.338	1.450	— .112	— 7.7	32.976	35.089	— 2.113	— 6.0	5.729	5.574	+ .155	+ 2.8
Okla.-Kans.-Mo.	.823	.746	+ .077	+10.3	17.058	18.974	— 1.915	—10.1	1.270	1.570	— .300	—19.1
Other Inland	.644	.676	— .032	— 4.7	17.205	17.931	— .726	— 4.0	3.103	2.619	+ .484	+18.5
Total Inland	2.946	3.059	— .113	— 3.7	74.130	79.375	— 5.245	— 6.6	10.841	10.855	— .014	— 0.1
Total East of Calif.	6.822	6.874	— .052	— 0.8	147.804	155.435	— 7.631	— 4.9	32.469	31.430	+ 1.039	+ 3.3
Calif.	1.186	1.111	+ .075	+ 6.8	25.169	22.122	+ 3.047	+13.8	17.669	14.111	+ 3.558	+25.2
Total U. S.	8.008	7.935	+ .023	+ 0.3	172.973	177.557	— 4.584	— 2.6	50.138	45.541	+ 4.597	+10.1

District	DISTILLATE FUEL OIL STOCKS (Millions of bbl on date shown) Aug. 9 1957	Aug. 10 1956	Change	% Change	KEROSINE STOCKS (Millions of bbl on date shown) Aug. 9 1957	Aug. 10 1956	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbl on date shown) Aug. 9 1957	Aug. 10 1956	Change	% Change
East Coast	50.915	42.193	+ 8.722	+20.7	13.117	11.187	+ 1.930	+17.3	64.032	53.380	+10.652	+20.0
Gulf Coast	23.722	22.691	+ 1.031	+ 4.5	6.729	5.869	+ .860	+14.7	30.451	28.560	+ 1.891	+ 6.6
Total Coastal	74.637	64.884	+ 9.753	+15.0	19.846	17.056	+ 2.790	+16.4	94.483	81.940	+12.543	+15.3
Appalachian	3.548	3.670	— .122	— 3.3	1.179	1.303	— .124	— 9.5	4.727	4.973	— .246	— 4.9
Ind.-Ill.-Ky.	24.134	21.023	+ 3.111	+14.8	7.115	6.954	+ .161	+ 2.3	31.249	27.977	+ 3.272	+11.7
Okla.-Kans.-Mo.	16.367	15.561	+ .806	+ 5.2	2.472	2.523	— .051	— 2.0	18.839	18.024	+ .755	+ 4.2
Other Inland	8.027	6.925	+ 1.102	+15.9	1.591	1.478	+ .113	+ 7.6	9.618	8.403	+ 1.215	+14.5
Total Inland	52.076	47.179	+ 4.897	+10.4	12.357	12.258	+ .099	+ 0.8	64.433	59.437	+ 4.996	+ 8.4
Total East of Calif.	126.713	112.063	+14.650	+13.1	32.203	29.314	+ 2.899	+ 9.9	158.916	141.377	+17.539	+12.4
Calif.	15.286	12.110	+ 3.176	+26.2	.351	.318	+ .033	+10.4	15.637	12.428	+ 3.209	+25.8
Total U. S.	141.999	124.173	+17.826	+14.4	32.554	29.632	+ 2.922	+ 9.9	174.553	153.805	+20.748	+13.5

Natural gas and refinery gas liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

	May 1957	Apr. 1957	May 1956
CURRENT PRODUCTION (1000 b/d monthly average)			
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	429	432	380
Natural Gasoline and Isopentane	300	303	297
Condensate	20	19	24
Finished Gasoline, Naphtha and other	64	67	58
Total Natural Gasoline and Cycling Plant Production	813	821	759
Liquefied Refinery Gases	149	146	143
Total Marketable Gas Liquids	962	967	902
Lease Condensate	135	142	125
Total Natural Gas Liquids	1,097	1,109	1,027
CURRENT DEMAND (1000 b d monthly average)			
LPG and LRG	452	520	449
Natural Gasoline, Isopentane and Other	377	391	380
Total Marketable Gas Liquids	829	911	829

	May 1957	May 1956
CUMULATIVE PRODUCTION (1000 bbl)		
LPG and LRG	89,619	84,604
Natural Gasoline, Isopentane and Other	57,742	56,806
Total Marketable Gas Liquids	147,361	141,410
CUMULATIVE DEMAND (1000 bbl)		
LPG and LRG	35,514	82,955
Natural Gasoline, Isopentane and Other	57,369	55,951
Total Marketable Gas Liquids	142,883	138,906

STOCKS (1000 bbl, end of month)	May 1957	Apr. 1957	May 1956
LPG and LRG	18,851	14,954	9,387
Natural Gasoline, Isopentane and Other	5,345	5,107	5,339
Total Stocks	24,196	20,061	14,726

INFORMATION OFFERED

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

Acetylene, plant design and construction, bulletin 257; Chemical Construction Co. See adv't. p. 243.

Aluminum, for corrosive service, specific bulletins available; Aluminum Co. of America. See adv't. pp. 27-30.

Antioxidants, for petroleum products, information; Davison Chemical Co. See adv't. p. 47.

Barium chemicals, for additives, booklet; Westvaco Mineral Products Div. See adv't. p. 201.

Burners, bulletin 111; Thermal Research & Engineering Corp. See adv't. p. 190.

Cleaning compounds, bulletins, Oakite Products, Inc. See adv't. p. 234.

Compressors, for refinery service, form 3132A; Ingersoll-Rand Co. See adv't. p. 49.

Dryers, gases, air or liquid, bulletin D-100; C. M. Kemp Mfg. Co. See adv't. p. 241.

Drying equipment, control air moisture, bulletins 112 & 121; Niagara Blower Co. See adv't. p. 184.

Engineering and development, booklet describes facilities; The Lummus Co. See adv't. p. 13.

Expansion joints, bellows type, catalog; Solar Aircraft Co. See adv't. p. 175.

Filters, heavy duty, bulletin; Sparkler Mfg. Co. See adv't. p. 204.

Filters, micronic, literature; Commercial Filters Corp. See adv't. p. 32.

Floating roofs, bulletin TS; Hammond Iron Works. See adv't. p. 199.

Gages, heated, for viscous fluids, catalog; Jerguson Gage & Valve Co. See adv't. p. 237.

Gaskets, catalog; Metallo Gasket Co. See Adv't. p. 230.

Glassed steel, pipe, fittings and valves, bulletin 886; Pfaudler Co. See adv't. p. 245.

Insulation, flat and curved, bulletin; Johns-Manville. See adv't. pp. 64-65.

Insulation, block and cement, information; Baldwin-Hill Co. See adv't. p. 247.

Insulation protection, fibrated asphalt base, brochure; American Bitumuls & Asphalt Co. See adv't. p. 238.

Jacketed elbows, aluminum, data; Childers Mfg. Co. See adv't. p. 99.

Jacketed pipe, fittings, bulletin J-57; Hetherington & Berner. Inc. See adv't. p. 211.

Mass spectrometer, portable, bulletin CEC-1843-X2; Consolidated Electrodynamics Corp. See adv't p. 186.

Mechanical seals, catalog 480; Durametalloc Corp. See adv't. p. 211.

Mixers, side and top entering, 8 catalogs and data sheets; Mixing Equipment Co., Inc. See adv't. p. 100.

Molecular sieves, absorbents, data; Linde Co. See adv't. p. 47.

Motor starters, high voltage, bulletin 8131-T; Electric Controller & Mfg. Co., Div. Square D Co. See adv't. p. 61.

Packing, braided, bulletin P-325; Crane Packing Co. See adv't. p. 244.

Packing, asbestos, semi-metallic, catalog; Allpax Co., Inc. See adv't. p. 236.

Pipe, plastic lined steel, information; Dow Chemical Co. See adv't. p. 185.

Processing equipment, fabrication, booklet; Newport News Shipbuilding & Dry Dock Co. See adv't. p. 170.

Refrigeration equipment, literature; Frick Co. See adv't. p. 237.

Steam generators, bulletin B-55-4; Foster Wheeler Corp. See adv't. p. 212.

Steam traps, brochure; Clark Mfg. Co. See Adv't. p. 242.

Steam traps, bulletin 1055; W. H. Nicholson & Co. See adv't. p. 22

Steam traps, impulse type, bulletin T-1739-X; Yarnall-Waring Co. See adv't. p. 62.

Steels, clad and alloy, bulletin; Lukens Steel Co. See adv't. p. 68-69.

Sulfurs, catalog booklet; Stauffer Chemical Co. See adv't. p. 98.

Thermometers, dial, mercury actuated, catalog; Palmer Thermometers, Inc. See adv't. p. 251.

Tower packing, booklet TT54; U. S. Stoneware Co. See adv't. p. 71.

Tube maintenance tools, cleaners, cutteres, expanders, bulletin 60; Airetool Mfg. Co. See adv't. p. 180.

Tube maintenance tools, expanders, cutters, catalog 81; Gustav Wiedeke Co. See adv't. p. 252.

Tubes, heat exchanger, steel, information; Republic Steel Corp. See adv't. pp. 82-83.

Tubes, reformer furnace, cast, bulletin T-283; Electro-Alloys Div. American Brake Shoe Co. See adv't. p. 50.

Valves, diaphram control, bulletin CV-53; Kieley & Mueller, Inc. See adv't. p. 48.

Valves, for liquids and gasese, bulletin CP6; Okadee Co. See adv't. p. 198.

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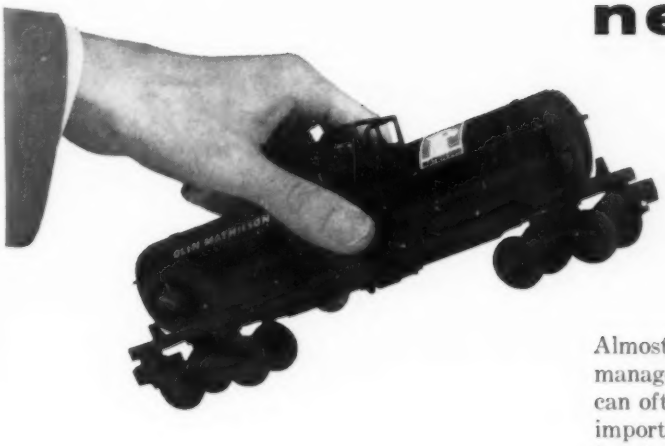
Vessels and tanks, clad, bulletin; Chicago Bridge & Iron Co. See adv't. p. 8.



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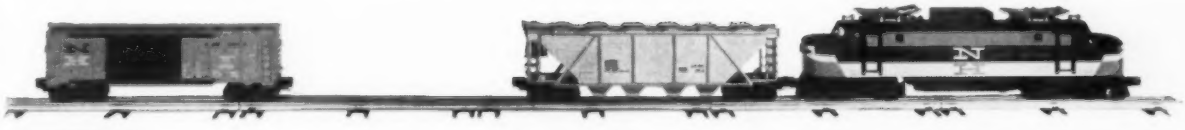

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A9	B9	C9	D9	E9	F9	G9	H9	J9	K9	L9	M9	N9	O9	P9	Q9	S9	T9	U9	V9

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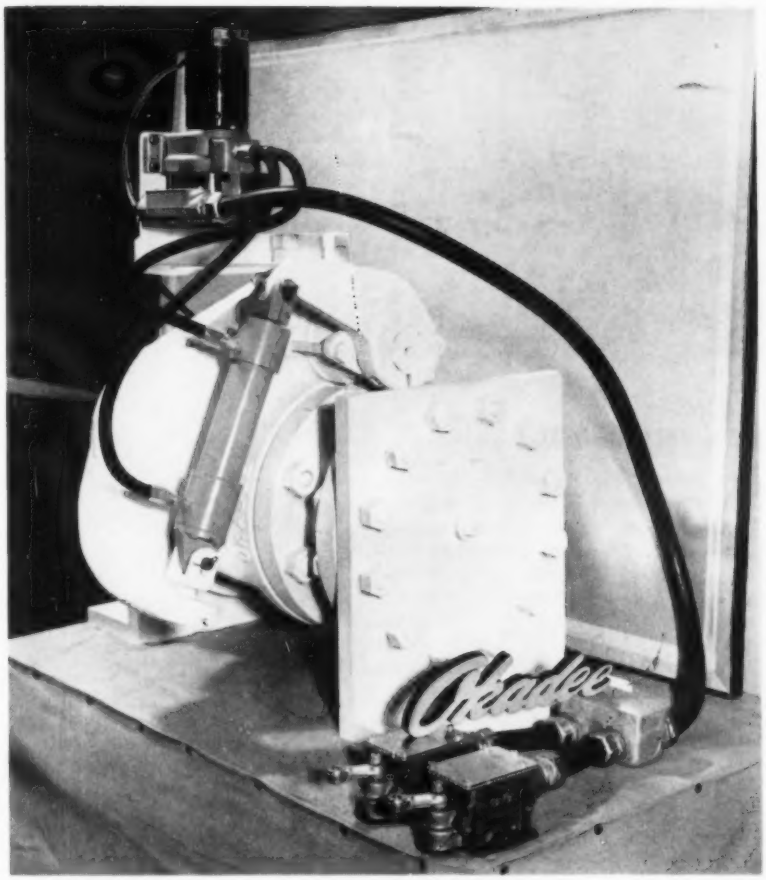
PDS 18,	**Process Reference List—1954**	**R48**
PDS 19,	**Powerforming**	**R51**
PDS 20,	**Cumene**	**R54**
PDS 21,	**HF Alkylation—Phillips**	**R56**
PDS 22,	**Ammonium Nitrate—Stengel-C&I**	**R58**
EDS 16,	**Instrument Terminology—A-F**	**R42**
EDS 17,	**Instrument Terminology—G-P**	**R49**
EDS 18,	**Instrument Terminology—R-Z**	**R52**
EDS 19,	**Unfired Pressure Vessel Code**	**R55**
EDS 20,	**Wire Rope**	**R57**
EDS 21,	**Unfired Pressure Vessels—Wall Thicknesses**	**R59**



Hydraulic operator handles large valves in small space

Designed for remote control of 4-in. valves and larger, this electro-hydraulic operator fits into the space used by a wheel-operated valve. A small high speed electric motor and a hydraulic gear pump are mounted integrally with the valve, and a hydraulic cylinder supplies the final movement needed to open and close large valves.

The gear pump can create pressures up to 3200 psi, which will permit the cylinder to open a 6-in. valve against a differential pressure ot 700 psi. Opening time is about 8 sec, with a similar closing time for the same operating conditions. This slow operation is a desirable feature when handling large volumes and pressures, and will prevent serious line shock. Even further speed reduction is possible by using a variable voltage transformer to control motor speed.

The hydraulic fluid used in the unit operates satisfactorily in temperatures from — 20 to 150°F. In case of power failure the motor and pump decelerate automatically, locking the cylinder when stopped. An over-ride feature to by-pass or unlock the cylinder is available. **The Okadee Co.,** 332 So. Michigan Ave., Chicago, Ill.

Circle No. **1** *on Reply Card*

Digital-control computer

. . . with transistorized parts is designed to control automatically processes in petroleum refining, chemical manufacturing and other industrial processes. It can also be used for general scientific computation and monitoring.

The RW-300 if used as the central unit of a process-control unit will read instruments, perform computations, determine control actions for best plant operation and activate set points on control loops. The computer weighs 400 lb and measures only 55 in. in length, 28 in. wide and 36 in. high. **The Ramo-Wooldridge Corp.,** 5730 Arbor Vitae St., Los Angeles 45, Calif.

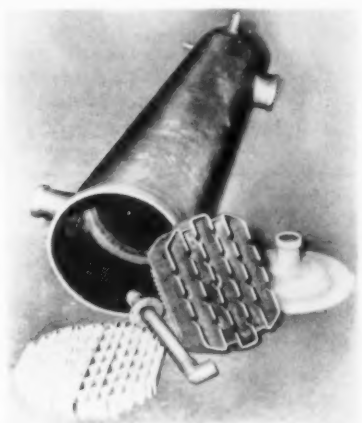
Circle No. **2** *on Reply Card*

Lube oil additives

. . . combine the desired effects of raising the viscosity index and lowering the pour point, plus having good resistance to shear breakdown.

Omavis 10 and 20 are the first in a new series of additives developed by Olin Mathieson. These two will give ASTM pour points of —30 to —50°F. They are light colored, viscous solutions of polymer in oil, chemically identical but differing in molecular weight. **Olin Mathieson Chemical Corp.,** 460 Park Ave., N.Y., 22, N.Y.

Circle No. **3** *on Reply Card*



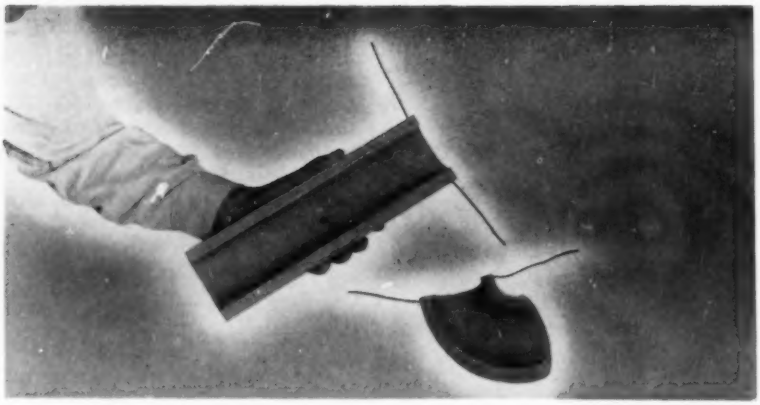
Plastic tower

. . . of polyester, glass-reinforced, can be operated continuously up to 212°F. Temperatures as high as 265°F are possible for intermittent service.

All parts of this absorption tower—grid plate, distribution trough, feed pipes and cap—are now produced in this light-weight polyester for less severe service. Formerly plastic towers had been made of asbestos-filled phenolic. Other towers for distillation and ion exchange can be made from glass reinforced polyester too. **Haveg Industries, Inc.,** 900 Greenbank Road, Wilmington 8, Del.

Circle No. **4** *on Reply Card*

(Continued on p. 226)



Electric elements

Heat pipes, tanks and tubing to 2,000°F

These custom-molded electric heating elements can be used to heat pipes, tanks or tubing to temperatures as high as 2,000°F. They can also be used for controlling process temperatures near room temperature, or a little higher. The heat release can be designed for almost any quantity up to 30 watts (or 100 Btu's/hr) per square inch.

Because the resistance coils are embedded in a strong ceramic, formed to conform to almost any intricate shape, hot spots are eliminated. Differential heat release can be predetermined at any part of the molded block, which also protects the resistance elements.

The terminals from each molded block have an enlarged cross-section to prevent overheating where they extend through the insulating walls. Voltage of 110 or 220 is normally used, although in some cases 440 volts may be used. Installation is simple and pieces molded like pipe insulation can be banded in place. Terminals from each heater are brought out to terminal boxes, which also may be secured to the pipe by banding. **Cooley Electric Manufacturing Corp.,** 50 Shelby St., Indianapolis 7, Ind.

Circle No. **5** *on Reply Card*

Low cost storage vault

. . . **for radioactive cobalt-60** replaces equipment costing 13 times as much. It has been approved by the Atomic Energy Commission as a safe storage container for cobalt-60 sources up to 1 curie in strength.

Part of the reason for the low cost is that the container is not meant for shipping purposes, so that it is constructed of heavy but low-cost materials. The vault consists of a section of 10-in. steel pipe reinforced at the bottom and filled with lead. In the center of the lead is a small space where the radioactive source is stored in a capsule approximately ½ in. long and ½ in. in diameter. A plug covers the space. The design provides a shield of lead 4½ in. thick on all sides of the capsule. **Baldwin-Lima-Hamilton Corp.,** Philadelphia 7, Pa.

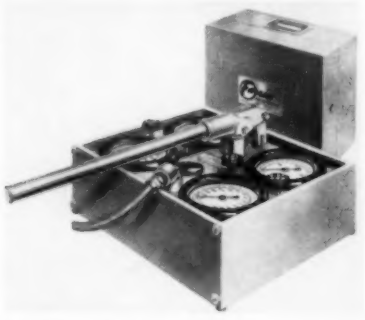
Circle No. **6** *on Reply Card*

Antiknock compound

. . . **for aviation gasoline** permitted power gains up to 20% in full-scale engine tests conducted on Curtis-Wright's 18-cylinder Turbo Compound engine.

Tentatively named AK-33X, the organic compound of manganese supplements the antiknock action of tetraethyl lead. It is hoped that the compound can benefit engines now in service by increasing detonation margins and thus improve combustion-chamber durability. Of course, if used in improved engines, it will enable aircraft to cruise faster, carry larger payloads and fly at higher altitudes with less fuel. Possibility of using the new additive for other motor fuels is being studied. **Ethyl Corporation,** N. Y. 17, N. Y.

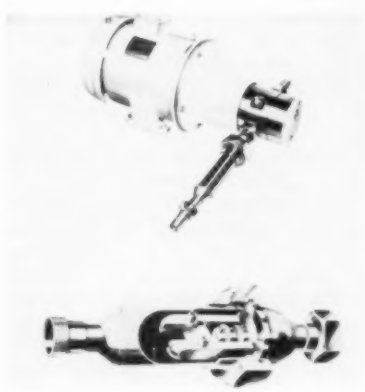
Circle No. **7** *on Reply Card*



Hydrostatic tester

. . . **for at-the-site work** is completely portable. The unit weighs only 55 lb and is complete with four test-accuracy gages and eight feet of hydraulic, flexible tubing. The pump handle folds in the storage case. Hydrostatic testing of valves, pressure vessels, piping and other equipment up to pressures of 3,000 psi can be made with this portable tester. **Farris Engineering Corp.,** 433 Commercial Ave., Palisades Park, N. J.

Circle No. **8** *on Reply Card*



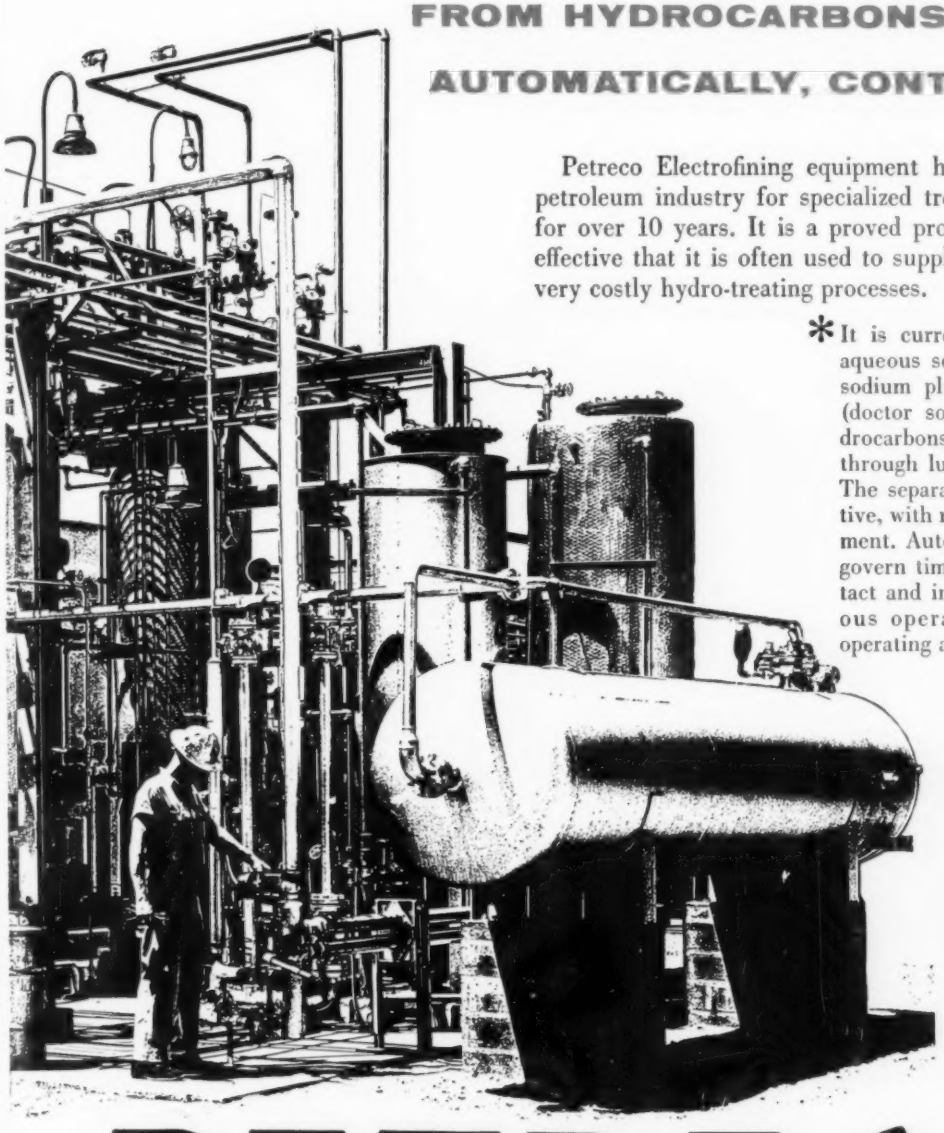
Ultrasonic emulsifier

. . . **uses the force** of moving liquid rather than electricity to generate the sound waves. This is accomplished by impinging the liquids to be emulsified

do you have a separation problem?

PETRECO ELECTROFINING EQUIPMENT

SEPARATES AQUEOUS-CHEMICAL SOLUTIONS* FROM HYDROCARBONS QUICKLY, AUTOMATICALLY, CONTINUOUSLY



Petreco Electrofining equipment has been used in the petroleum industry for specialized treating of light stocks for over 10 years. It is a proved process, so efficient and effective that it is often used to supplement or replace the very costly hydro-treating processes.

*It is currently used to separate aqueous solutions of acid, alkali, sodium plumbite-caustic solution (doctor solution) from light hydrocarbons ranging from gasoline through lubricating oil distillates. The separation is rapid and positive, with minimum or nil entrainment. Automatic, pre-set controls govern time and intensity of contact and insure efficient, continuous operation with minimum operating attention.

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NATIONAL AIROIL *exclusive* Tandem Combustion Units achieve this capacity with maximum economy and availability.

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NATIONAL AIROIL Tandem Units are recognized as standard firing equipment in oil refinery and chemical plant heaters throughout the world. They are noted for versatility regarding fuels; and insure correct flame placement so necessary to avoid damage to the heat-absorbing tubes. Your furnace maintenance problems are measurably reduced, and hours on stream greatly increased by use of Tandem Combustion Units.

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OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

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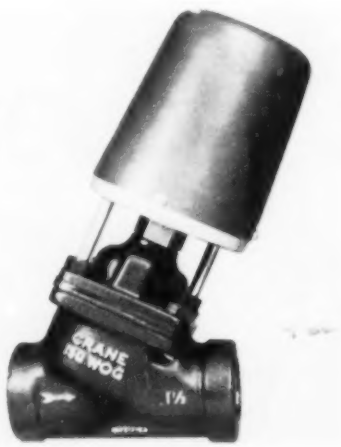
What's new (continued)

in a jet stream on the edge of a sharp blade. Subject to this jet, the blade vibrates at its natural frequency of about 22,000 cps. The result is ultrasonic vibration and cavitation of the liquid, producing emulsification.

For use in the manufacture of creams, lubricants and other chemicals, this type of emulsifier is available in three sizes. The Rapisonic has an output of 350 gal/hr and handles emulsions of high and low viscosity. The Autosonic has a varying output between 100 and 250 gal/hr. The Dispersonic is designed to handle dispersions of powders in liquids or emulsions of an abrasive nature. It uses a continuous-cavity pump rather than the gear pump used in the other two models.

Emulsifiers of this mechanical design are able to use all of the energy developed directly in the vibratory motion that results in emulsification. As a result, the machines are easy to maintain and less expensive than other types. **Sonic Engineering Co.,** 146 Selleck St., Stamford, Conn.

Circle No. **9** *on Reply Card*



Electric valve controller

. . . **mounts directly on the stem** of any common valve. It is mounted so that in the event of power failure the valve can be turned by a wrench.

The Valvetrol is a self contained gear motor with a hollow output shaft that receives the valve stem. Stem diameters from ¼ to 1 in. can be accommodated, and when used on a rising stem valve, the adaptor "swallows" the stem.

A wide variety of Valvetrol gear ratios are available to produce the desired torque and operating speed. Selective gear ratio to the potentiometer adapt this valve controller for valves having 1/6 to 40 turns to full open. Totally enclosed or explosion proof construction is available. **The Jordan Co.,** 3235 West Hampton Ave., Milwaukee 9, Wis.

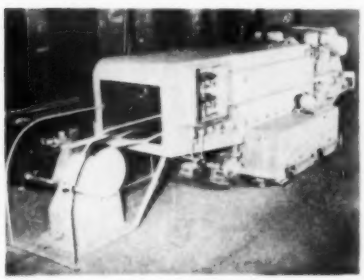
Circle No. **10** *on Reply Card*

Beam compass

. . . **the size of a half dollar** can disgorge enough linen thread to scribe circles up to 12 ft in diameter. It can also be used to draw large, complicated involute curves and spirals.

The "Sidewinder" is a turret-shaped metal compass with a linelocking clutch and sensitive rewind knob, which permits measurements accurate to fractions of an inch. The reel is anchored to the work surface by a pin, and three interchangeable pins act as seating anchors, rewind handles and curvature guides. **Laramie Chemical Corp.,** 290 Main St., Stamford, Conn.

Circle No. **11** *on Reply Card*



Drum reconditioner

. . . **for cleaning 55-gal drums** restores the original bare metal surface on the ends and exterior sides. At a production rate of 2 per minute the drums are then ready for painting.

This "Junior" drum reconditioner removes all paint, rust and dirt from old drums by wire brushing the ends and sides. An automatic drum loader feeds the drums into the machine. **Lowe Engineering Co.,** Lincoln Park 1, N. J.

Circle No. **12** *on Reply Card*

Aluminum-on-glass-fiber

Suit protects fire fighter

Offering protection against propane fires or gasoline blazes, this special suit permits a fire fighter to enter flames reaching temperatures of 2100°F for brief periods. The wearer can breathe air supplied directly from a Scott air pack worn under the arm and beneath the special coat.

The fire-fighting suit consists of a three-quarter length coat, chest-high pants, boots reaching halfway up the shin, and a helmet which overlaps the shoulder and chest. The fabric consists of a micro-thin coating of aluminum over glass fiber material, so that 95% of the radiant heat is reflected. The material is light enough to permit a man to work freely and effectively in an emergency. Backing up the aluminum-coated glass fiber material is quilted glass fiber insulation.

The aluminum-coated material is one of several types made by Minnesota Mining and Manufacturing Co., St. Paul, Minn. The suit is made by **Fyrepel Products, Inc.** Newark, Ohio.

Circle No. **13** *on Reply Card*

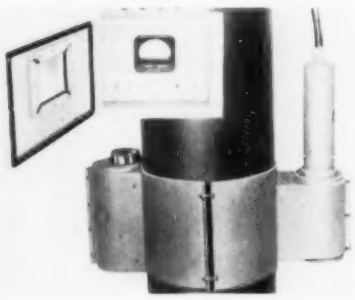
Mechanical Btu meter

. . . measures heat in thermal units and liquid flow in gallons. It can be used in metering central heating and refrigeration lines or in measuring the quantity of heating and cooling consumed in individual areas.

The Pollux B.T.U. meter consists of a liquid meter and an integrator. The liquid meter measures the flow of liquid. The integrator combines the difference between the supply-and-return liquid temperatures and the flow through the liquid meter, giving a resultant product in Btu's totalized on the counter. The number of gallons is recorded on a second counter. Directly above these two counters is a pointer indicating the instantaneous temperature difference of the supply-and-return liquid in °F.

The meter is corrosion proof, easily installed and requires no lubrication. A remote counter can be installed if needed. **Air Conditioning Equipment Corp.,** 219 E. 44th St., N.Y., N.Y.

Circle No. **14** *on Reply Card*



Radioactive gage

. . . measures density, specific gravity or percent solids of a flowing process material. There is no need to disturb the flow in the measured pipe because all parts of the instrument are mounted externally.

The Model LSG radioactivity density gage, if installed on a pipe of 10-in. diameter, has a span of 0.2 and a precision of ± .004. It may be used on pipes both larger and down to 3-in. in diameter. The radioactive source is mounted on one side of the process pipe and the measuring cell and amplifier are bracketed directly opposite. A power supply of 110 volts, 60 cycle AC is required. **The Ohmart Corp.,** Dept. 152, 2236 Bogen St., Cincinnati 14, Ohio.

Circle No. **15** *on Reply Card*

Gas-density balance

. . . measures specific gravity or density of hydrocarbon process streams. Where density is an index to properties of the gas stream, this instrument can be used to detect slight variations.

The 3A gas-density balance measures the gas by a unique null-balance principle. A small dumbbell is supported on a horizontal quartz fiber. One bell is punctured so that it will not experience buoyancy effects. The other bell tends to rise or dip as the density of the gas changes. Thus, the

Fabricated in special shapes to exact specifications. Under fatigue of severe operating conditions, they are superior in sealing efficiency, longevity and ability to retain physical and chemical properties. These gaskets are built for specific purposes in strict accordance with customers' requirements or templates. When used for recommended services, they completely satisfy and give extra long life. A group of specially constructed metallo Gaskets are made for heat exchangers with metal jackets and asbestos filler. These gaskets, including irregular shaped gaskets for any process equipment, are readily made in several different styles and shapes, in any metal and in sizes limited only by transportation facilities. These gaskets are also cut from solid sheet metal.

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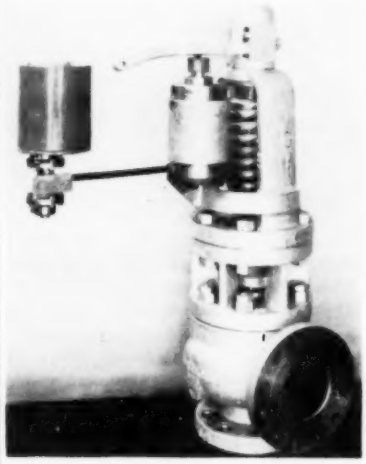
dumbbell experiences a rotational force about the quartz fiber as it responds to density changes. The magnitude of the force is proportional to the density of the sample gas.

A 95% response is obtained within less than a minute with this balance. Sensitivity is ½% of full scale and accuracy is 1½% of full scale. Ranges of 0.05 total span relative to air anywhere from 0 to 5,000 are available. Standard output is 0-5 millivolts. **Arnold O. Beckman, Inc.,** 1020 Mission St., South Pasadena, Calif.

Circle No. **16** *on Reply Card*



Safety valve

. . . **for protection against overspeed** in a low-pressure turbine has an added safety feature. An air-lift cylinder has been added to the conventional spring-loaded valve to lift the valve to its full discharge capacity at any pressure down to zero. The air-lift cylinder will open the valve to its full capacity in less than 1/10 of a second. It is controlled by an over-speed switch which acts immediately. **Crosby Valve and Gage Co.,** 43 Kendrick St., Wrentham, Mass.

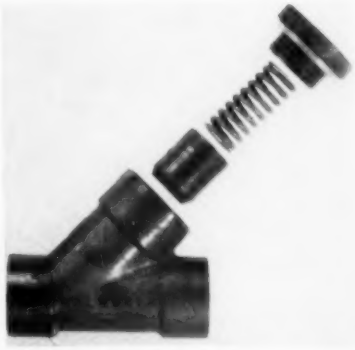
Circle No. **17** *on Reply Card*

Zinc coating

. . . **can be brushed or sprayed** on steel for galvanic protection. A tight, non-porous 4 to 10 mil film can be applied over power-brushed rusty steel for service other than tank linings; there is no need for sandblasting.

The new formulation has a lower zinc content and greater binder strength than older type zinc coatings. Three types are available: XR 150-40 for lining fresh-water tanks and pipes; XR 150-62 for lining brine tanks and protecting sandblasted steel from marine and industrial atmospheres; and XR 150-43 for application to rusty, wirebrushed structural steel in industrial and marine atmospheres. **The Carboline Co.,** 331 Thornton Ave., St. Louis 19, Mo.

Circle No. **18** *on Reply Card*

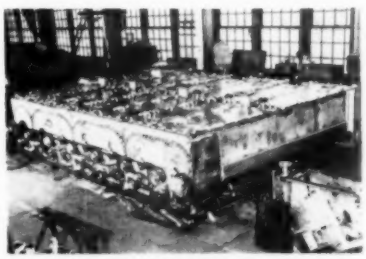


Plastic check valve

. . . **of rigid polyvinyl chloride** operates at pressures up to 150 psi at 75° F. Even the spring of the all-plastic valve is made of PVC, and has stood up under 2-million continuous cycles under 126 psi of air and 50 psi of water.

The valve is designed to resist corrosion from alkalis, acids, inorganic salt solutions and other corrosive materials. It is available for pipe varying from ½ to 2-in. in diameter. Ends may be threaded, flanged or designed for solvent welding. **Walworth Co.,** 60 East 42nd St., N.Y., N.Y.

Circle No. **19** *on Reply Card*



Solid-liquid contactor

. . . **features slow tumbling** while moving material in a horizontal path. This prevents channeling of the liquid, often encountered in vertical units.

A horizontal trough is the basic unit of this contactor, and can be used in any number desired. A rotating shaft down the center of each trough has

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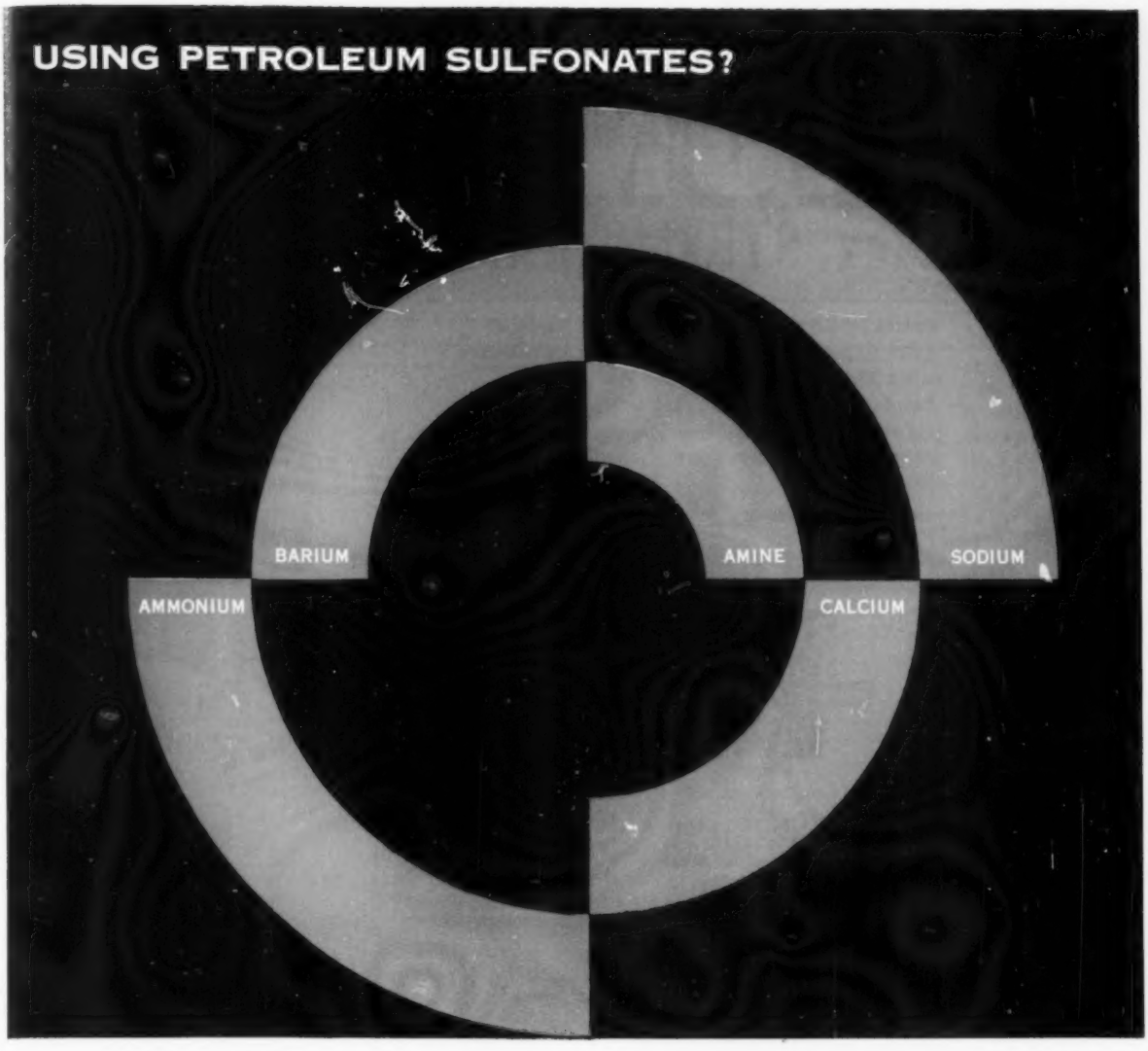

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 (To obtain more data on advertised products see page 222)

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STRONG Hydro-Flex STEAM TRAPS provide all these advantages:

GREATER CAPACITY . . . thru STRONG "lever-lift" trap action
BETTER HEATING . . . thru rapid elimination of air and condensate
HIGHER EFFICIENCY . . . even under very light loads
LONGER LIFE . . . thru extra-heavy cast or forged construction
LESS WEAR . . . only two parts move — no pins on larger traps
INTERCHANGEABLE INTERNAL PARTS . . . made of tough stainless steel

STRONG'S complete line contains a trap for every steam system: 0 to 2500 psi, 0 to 1100°F, 0 to 100,000 lbs/hour.

Horizontal, in-line traps:

140, 141, 142, 143, 144 (semi-steel): pressure-temperature limit — 250 psi at 450°F; capacities to 11,500 lbs/hour

140S, 141S, 142S (semi-steel): same as 140-142, with a built-in strainer for removing foreign matter.

140T, 141T, 142T (semi-steel): same as 140-142, with a high capacity thermal vent for faster heating

Bottom inlet, top outlet traps:

42, 43, 44, 45, 46 (semi-steel): pressure-temperature limit — 250 psi at 450°F; capacities to 42,800 lbs/hour

643, 644, 645, 646 (cast steel): pressure-temperature limit — 600 psi at 800°F; capacities to 42,800 lbs/hour

1543, 1544, 1545, 1546 (forged SAE 4130 Chrome-Moly Steel): pressure-temperature limit — 1500 psi at 950°F; capacities to 42,800 lbs/hour

642 (forged steel): pressure-temperature limit — 400 psi at 850°F; capacities to 2665 lbs/hour (not illustrated)

2544, 2545, 2546 (forged ASTM A335-P22 Chrome-Moly Steel): pressure-temperature limit — 2500 psi at 1100°F; capacities to 42,800 lbs/hour (not illustrated)

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air traps • strainers • vacuum or pumping traps
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paddles attached to form an interrupted helix, which conveys the material and mixes at the same time. At the solid discharge end is a scoop attached to the rotating shaft that pushes the solids out into a conveying system.

For counter-current operation, solid material is fed into an entrance port and conveyed to the discharge end, where the liquid enters. Either solid or liquid can be removed at the end of its path or at intermediate points. **Gifford-Wood Co.**, Hudson, N.Y.

Circle No. **20** *on Reply Card*

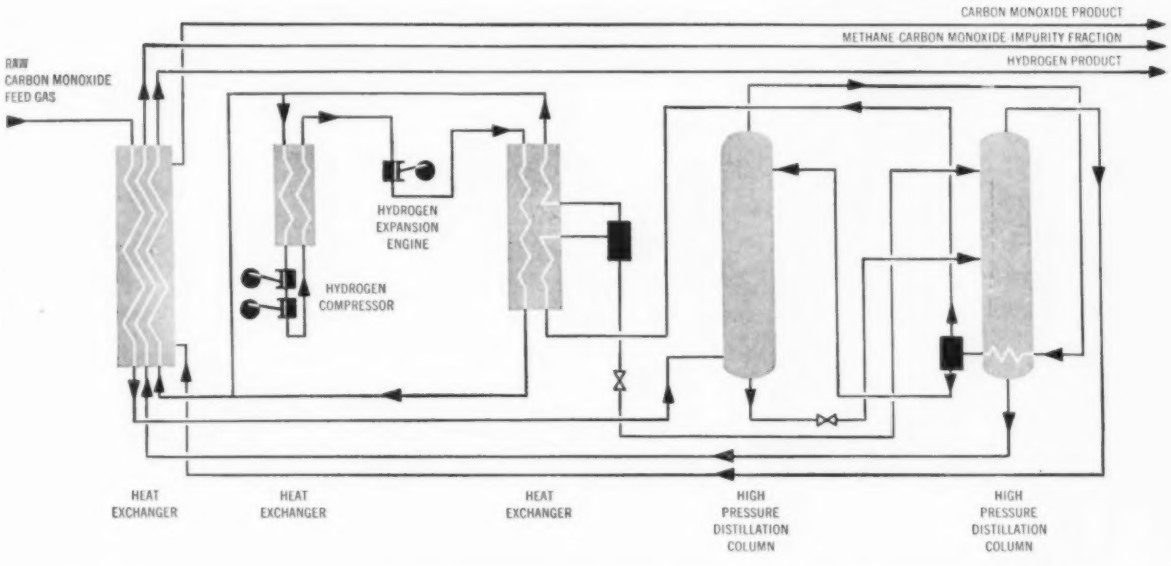
Liquid-level transmitter

. . . operates as a d/p cell using a silicone-filled diaphragm capsule as the level measuring element. It is assembled in a 3-in. flange for mounting on the side nozzle of a vessel.

The Type 13 FA d/p cell transmit-

• • •

A new approach to production and purification of carbon monoxide from crude synthesis gas



In the production and final purification of carbon monoxide from crude synthesis gas, low-temperature processing plays an important part. Synthesis gas—produced by steam reforming or various partial oxidations—contains CO, H_2 and some carbon dioxide. From this composition, it is possible to recover up to 95% of the CO, as a product of up to 99.5% purity, using low-temperature equipment designed and built by Air Products, Incorporated.

Air Products carbon monoxide purification plants feature:

. . . high-purity carbon monoxide and hydrogen product streams
. . . maximum recoveries—higher capital return
. . . automatic control—minimum labor requirements
. . . low power consumption
. . . factory assembled plants—with low installation expense

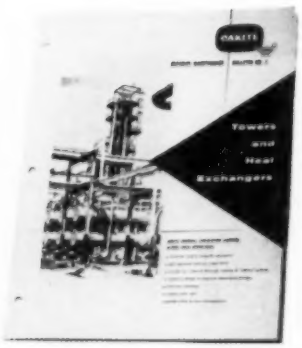
Low-temperature processing is not limited to just this type of gas purification. Designs are available and plants have already been built for such processes as . . . recovery of helium and nitrogen, separately, from natural gas . . . purification of methane . . . recovery of pure hydrogen from cracked petroleum off-gas streams. New processes are constantly being developed, and can be tailored to your needs.

Integrated design, manufacture, erection and operation of Air Products plants makes possible guaranteed results . . . for gas separation, liquefaction and purification systems. Plants are built to customer specifications. Ask us how low-temperature processing can be put to work for you. Your inquiry is invited. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

Air Products ...INCORPORATED

 (To obtain more data on advertised products see page 222)

2 New refinery maintenance bulletins show the way to save down-time in a big way!



Bulletin No. 1

Oakite chemical circulation cleaning of towers and heat exchangers described fully, with graphs and illustrations. Explains in-place cleaning with no dismantling, less down-time and greater safety to men and equipment.

Bulletin No. 2

Shows how to clean storage tanks and strip paint at least cost for time and material... with thorough soil and paint removal, minimum product contamination. Charts and illustrations.

FREE! These valuable new bulletins are part of a series being published by the Petroleum Service Division of Oakite, covering typical refinery maintenance operations. They reflect the practical experience of Oakite men working intimately with the petroleum industry... working toward better, faster ways to do the job. Get your free copies of these bulletins through your local Oakite man, or by writing to Oakite Products, Inc., 50D Rector Street, New York 6, New York.

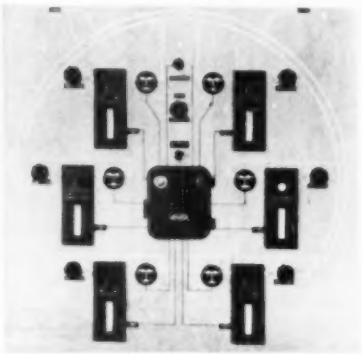
Export Division Cable Address: Oakite

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

Technical Service Representatives in Principal Cities of U. S. and Canada

ter operates on the force-balance principle. Liquid head in the vessel applies force to the high-pressure side of the cell. The low-pressure side may be open to atmosphere or connected to the top of a closed tank to balance static pressure. The pneumatic output of the transmitter—a 3-15 psi signal proportional to the tank level—will operate a remote recorder, indicator or controller. No auxiliary signal amplifier is needed. **Foxboro Co.,** Foxboro, Mass.

Circle No. **21** *on Reply Card*



Tank selector

. . . automatically controls the filling of storage tanks in sequence or on a fill-when-empty basis. A scanning operation permits checking each tank to determine which needs filling next.

In operation, the ATS selector-controller automatically senses the liquid level of each tank in the system through a level transmitter. It then automatically opens the fill valve or cycles to the next tank, depending on whether the tank is empty or full. Each ATS circuit can handle up to 12 tanks; two or more selectors can be connected to control any number of tanks.

The system requires one control valve and one level transmitter for each tank, plus one selector-controller for every 12 tanks. A pneumatic circuit connects the remote selector-controller in a control house and the level transmitters and control valves in the tank farm. **Mason-Neilan,** 60 Nahatan St., Norwood, Mass.

Circle No. **22** *on Reply Card*

Hydrogen blistering

. . . prevention process, patented by Shell Development Co., is now available to the refining industry through a royalty free license.

Shell's process, U. S. Patent No.

HAVE YOU GOT THE FACTS ABOUT YOUR BUSINESS?

It's surprising how little oil's customers know about the biggest selling petroleum product—gasoline! They never see it or touch it—yet they *use* it every day. All they know is the price they pay . . . and only a few know how big a bargain they really get with today's gasoline.

You'll be helping yourself and your industry by giving oil's customers the *real* story about today's gasoline prices and taxes. Here are the facts:

Direct Taxes add 40 cents to every dollar spent for today's gasoline!

When you hear the phrase "gasoline prices are high," this is your best reply: "Gasoline *taxes* are high, but gasoline *itself* is a bargain!" Yes, it's true that for every dollar spent for gasoline, an additional 40¢ must be paid for federal and state gasoline taxes!

Mr. Average American Motorist—who drives his car approximately 9,360 miles a year—pays $56.76 in direct taxes on gasoline alone! That's an average of 8.8¢ a gallon—a rate four times higher than the federal 10% tax on "luxuries" like mink coats!

But let's look at the price of gasoline *itself*. Gasoline has gone up only a few pennies, in the last five years. Meanwhile, gasoline quality has improved tremendously, so that today's *regular* gasoline is as good as premium gasoline was only five short years ago. And today's *premium* gasoline is as powerful as the bomber and fighter gasolines of the last war.

So next time you are asked about gasoline prices, remember . . .

WITH TODAY'S GASOLINE YOU DRIVE THE BEST BARGAIN IN YEARS!

American Petroleum Institute, Dept. G
50 W. 50th St., New York 20, N. Y.

I would like to obtain more information about today's gasoline quality, prices and taxes. Please send me your FREE booklets.

NAME _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

Where Temperatures and Pressures "GET HIGH"

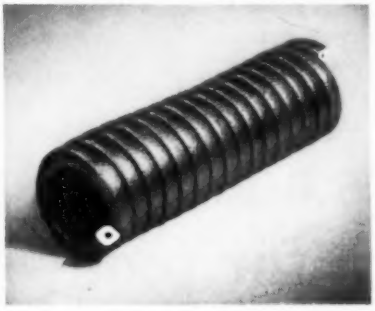
...you need these packings!

Style HP-2M – excels against severe temperatures and pressures. A braided asbestos packing reinforced with a monel wire insertion. For use on centrifugal and reciprocating pumps, valve stems, expansion joints, etc.

Style No. 30 – a very dense braided asbestos packing, highly resistant to high pressures. For use against petroleum products at high temperatures and pressures.

Style HP-RC – a wrapped asbestos cloth packing with a resilient rubber core. For use on steam hammers, expansion joints, pumps and piston rods calling for high pressure steam, air and gases at temperatures to 600 degrees F.

Style HP-RB–for high pressure steam service up to 600 degrees F. Constructed with a core of accordion-folded asbestos cloth and a resilient rubber back, around which is wrapped a closely woven asbestos cloth jacket.



Aquapak Hydraulic Packing – a semi-metallic packing designed to withstand severe hydraulic pressures. Will give satisfactory service on pressures as high as 10,000 pounds. For use against hot and cold water on centrifugal and reciprocating pumps, outside packed boiler feed pumps and similar equipment.

ALLPAX

"The Packing that Packs All"

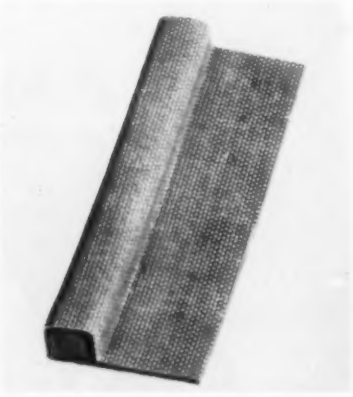
SEND FOR OUR NEW CATALOG — TODAY!

A complete line of packing, tools, gasket materials. Ask for dealer information and price schedules.

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 8, Quebec

2,780,583, inhibits the penetration of hydrogen into steel and prevents blistering. Small amounts of air are injected into the processing equipment. To maintain proper alkalinity, ammonia is added also. **Shell Development Co.**, 50 West 50th St., N. Y. 20, N. Y.

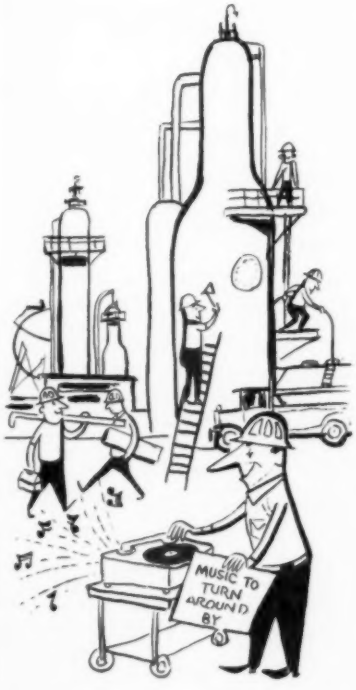
Circle No. **23** *on Reply Card*



Fabric seals

. . . **fluoro-silicone** rubber will withstand temperatures from —65 to 400° F and resist attack by aviation fuel and synthetic oils. Although the

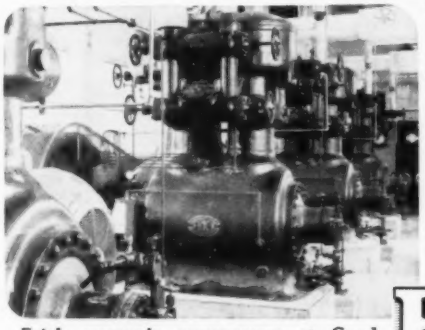
• • •



GOODYEAR'S NEW CHEMIGUM PLANT EQUIPPED WITH FRICK REFRIGERATION

This versatile plant, just completed at Akron, makes many types of rubber, latices and plastics. The big reactors, each holding 3000 gallons, are lined with glass; each is cooled with seven banks of glass-coated ammonia coils of the patented Frick direct-expansion design.

These coils, with their control system, enjoy a world-wide preference for use in chemical reactors.



Frick ammonia compressors at Goodyear's new plant in Akron, Ohio.

Four Frick compressors of 12 in. bore and 12 in. stroke, together with a 5 by 5 machine, carry the refrigerating load under automatic and semi-automatic controls.

When you want the most durable and efficient refrigerating equipment, whether for air conditioning, process work, ice making, quick freezing or other cooling service, specify "Frick". Literature and estimates on request.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U.S.A.

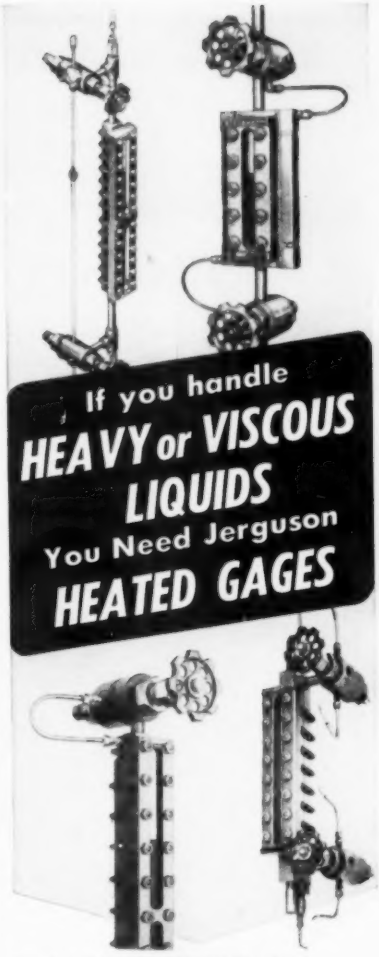
engineering
layout
design
drafting

your flowcharts and specs into finished working drawings

MAY WE BE OF SERVICE?

NORMAN ALEXANDER INC.

80 EAST JACKSON BLVD
CHICAGO 4, ILLINOIS



In the COMPLETE LINE of Jerguson Heated Gages there is a model to meet your specific needs . . . heated by steam or electrically

You can accurately gage heavy or viscous liquids with Jerguson Heated Gages . . . and the line is so complete there is a model to meet your specific problem. Made in Reflex or Transparent styles, in External or Internal Tube models, as well as a large chamber model with dual tubes. Heated by steam, hot fluid, or electrically. Furnished with special jacketed heated-gage valves, union or non-union connections. You get accurate, dependable gaging of heavy or viscous liquids, or protection for cold weather installations.

Ask for Jerguson Heated Gage Catalog

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY
100 Adams Street, Burlington, Mass.
Offices in Major Cities
Jerguson Tress Gage & Valve Co., Ltd., London, Eng.
Pétrole Service, Paris, France

INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for our free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

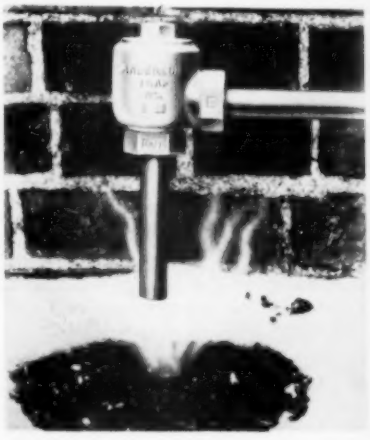
American Bitumuls & Asphalt Company

200 Bush St., San Francisco 20, California
Baltimore 3, Md. · Mobile, Ala. · Inglewood, Calif. · St. Louis 17, Mo. · San Juan 23, P.R. · Oakland 1, Calif. · Perth Amboy, N. J. · Cincinnati 38, Ohio · Tucson, Ariz. · Portland 7, Ore.

tensile, tear and elongation properties of this fluoro-silicone rubber are similar to conventional silicone rubber, it does not swell and disintegrate when exposed to aviation fuel.

These seals at present are being produced for aircraft manufacturers, but potential uses in a refinery producing these aviation fuels are many. Fabric is used for reinforcement to provide abrasion and tear resistance, similar to that of seals made of usual silicone rubbers. **Connecticut Hard Rubber Co.**, 407 East St., New Haven 9, Conn.

Circle No. **24** *on Reply Card*



Freeze-proof trap

. . . for outdoor installations handles up to 31,000 lb/hr of condensate.

The Quik-flex steam trap, in pipe sizes from ½ to 1¼ in., is designed with a downward flow of steam and condensate, permitting automatic draining at all times. Special alloy in the valve and seat give good corrosion and scoring resistance. A removable cap permits easy maintenance and access to the interior without disconnecting pipe fittings. A monel bellows is the actuating device, expanding when steam enters the trap and contracting and dumping the trap when condensate or air drops the temperature. **V. D. Anderson Co.**, 1935 West 96th St., Cleveland 2, Ohio.

Circle No. **25** *on Reply Card*

Gasoline sweetener

. . . uses a selective catalyst to promote more rapid oxidation of sulfur compounds in gasoline. The new additive, UOP No. 5-S, retains the potency and water-insolubility of UOP No. 5 Inhibitor but accomplishes sweetening in ¼ to ¾ the time required with No.

Pride that Pays Off

Kellogg's plant people at Jersey City showed justifiable pride in their work when they modified this familiar sign in the company's railroad siding.* On its way to a major chemical company, the Masterweld unit is one of the largest heat exchangers ever built. Whether your heat transfer requirements need specially designed giants like this or standard type units, the personal pride of Kellogg's personnel in their designing, engineering, and fabrication pays off in longer and more satisfactory service for Kellogg's customers.

FABRICATED PRODUCTS DIVISION

THE M. W. KELLOGG COMPANY

711 THIRD AVENUE, NEW YORK 17, N. Y.

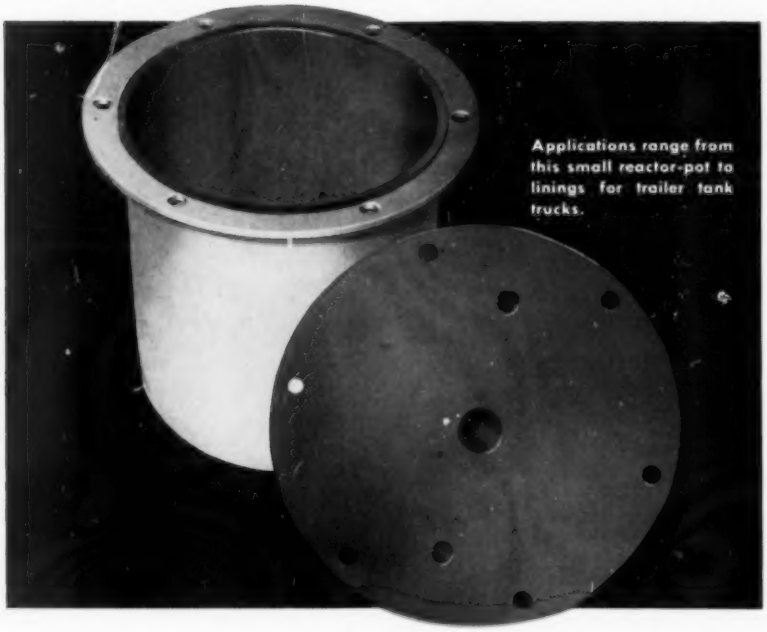
A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Limited, Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

*With apologies to Nationa lSafety Council Inc. for the temporary defacement.

now make any vessel

CHEMICAL RESISTANT...



...with KEL-F LAMINATE lining

Here is a method for making ordinary plant equipment (new or existing) resistant to gases and liquids as corrosive as fuming nitric acid—and at reasonable cost.

KEL-F Laminate comprises a tough, shatterproof, abrasion-resistant, frictionless surface of KEL-F* fluorocarbon plastic, bonded to a glass-cloth backing for maximum adhesion. It is readily cemented to any material of construction—metal, wood, concrete, etc.—and over a variety of contours.

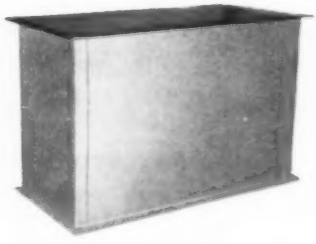
KEL-F, being a thermoplastic resin, seams may be "heat-welded". The result is a continuous surface having zero water absorption and extremely resistant to acids, alkalies, oxidants and solvents at temperatures up to 350°F.

KEL-F Laminates are manufactured by the United States Gasket Company, pioneers and leaders in fluorocarbon plastics, and are available for installation by certified applicators. Write for further information and the name of applicator nearest you.

UNITED STATES GASKET COMPANY, Camden 1, New Jersey

*Trademark, Minn. Mining & Mfg. Co.

100 gal. Tank handling acid fluorides, lined with KEL-F Laminate.

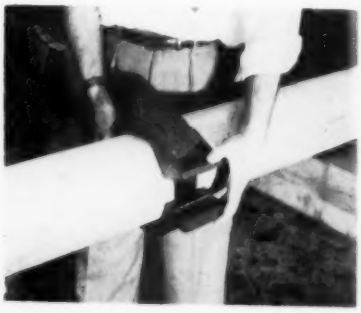


United States Gasket *Plastics Division*

OF THE GARLOCK PACKING COMPANY

5. The formulation has been proved in laboratory tests and commercial tests to be better than previous inhibitors where inhibitor sweetening is the controlling factor in choice. **Universal Oil Co.,** 30 Algonquin Road, Des Plaines, Ill.

Circle No. **26** *on Reply Card*



Coupling

. . . quickly joins light-wall, stainless-steel lines. No preparation is needed on the pipe ends, and only an open end or ratchet wrench is required.

A tapered gasket design with an internal lip gives a smooth seal between the two sections of pipe. The gasket compresses within itself as the steel clamp is tightened around it. The gasket moves uniformly around the pipe, affording allowance for misalignment of pipe ends.

Couplings are designed for working pressures of 100 psi and for pipe sizes up to 12 inches. Gaskets are available in various compositions of synthetic and natural rubber. **Swepco Fittings, Inc.,** 6 Clifton Blvd., Clifton, N. J.

Circle No. **27** *on Reply Card*

Free trade literature

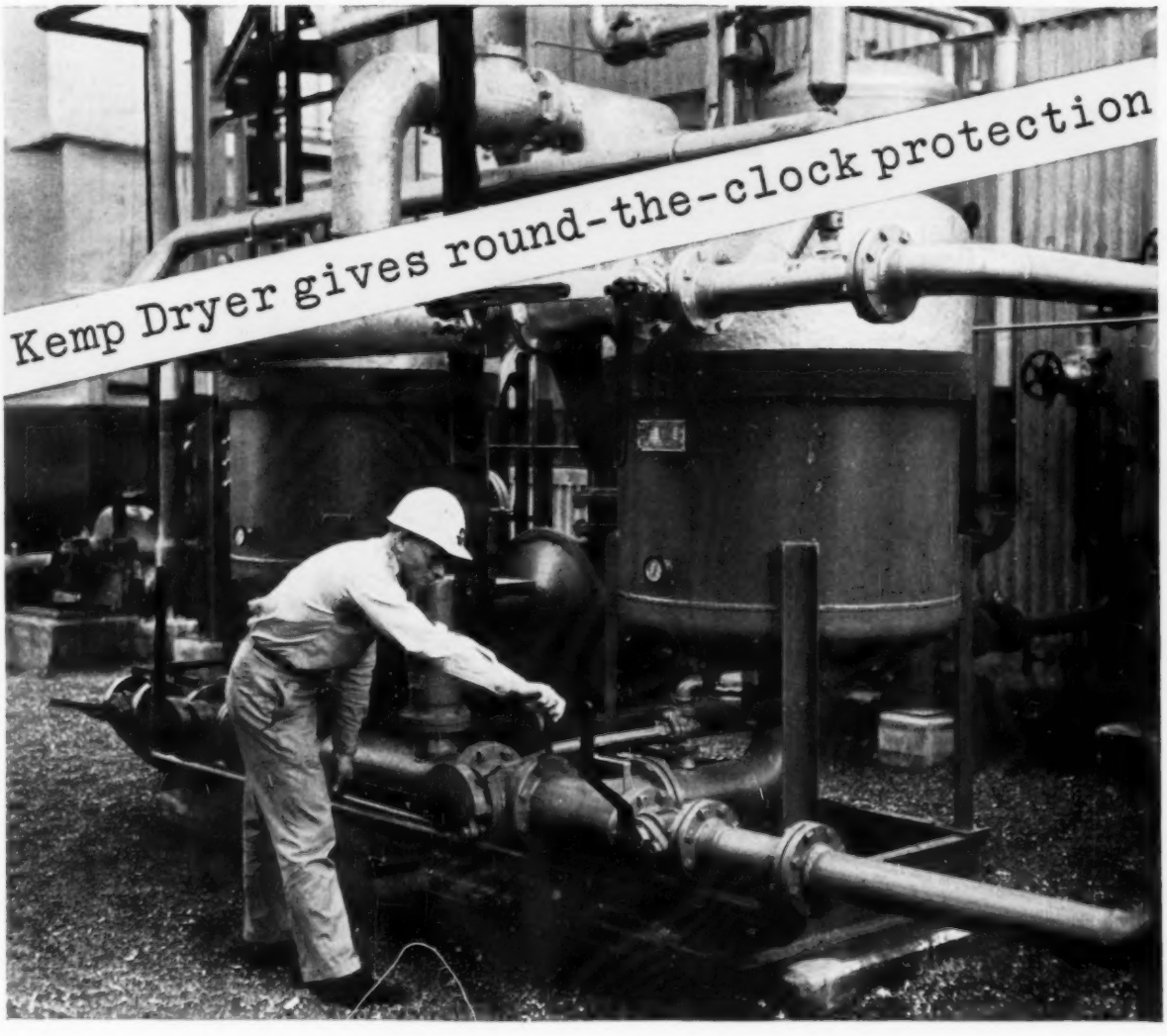
Frequency measurements

. . . and how to make them: *Data File 111* is a 17-page booklet on frequency meters and their uses. Covered are such topics as measuring low and UHF frequencies, rotational velocity, pressure, temperature and strain. The manufacturer's equipment used for this measurement indicates in decimal form frequencies from 0 to 1005 megacycles per second. Beckman/Berkeley, 2200 Wright Ave., Richmond 3, Calif.

Circle No. **28** *on Reply Card*

PVC pipe

. . . and its properties: *Bulletin A 557* is a 12-page catalog listing two types



Grace Chemical Company Reports: *Kemp Dryer safeguards instruments throughout plant 24 hours per day*

The Grace Chemical Co. manufactures Anhydrous Ammonia and Urea 24 hours a day at Woodstock, Tenn. This operation demands instrument accuracy with a minimum of maintenance and downtime. To increase instrument efficiency by preventing corrosion and costly line freezes, Grace Chemical installed a Kemp Dryer.

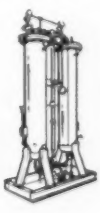
Kemp Requires Little Attention

Semi-automatic, the Kemp Dryer works night and day drying compressed air for instruments and pneumatic controlled valves. According to operator Charles Lewis, the Kemp unit requires a bare minimum of attention.

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air, gases or liquids to sub-zero dew points at a low cost, they are constructed of quality materials and embody the engineering knowledge gained from Kemp's many years of experience. Kemp Dryers are available with manual, semi-automatic, or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each drying job. If you have a problem involving the removal of water from air, gases, or liquids, contact Kemp engineers now. For complete facts, technical information, write for Bulletin D-100.

KEMP
OF BALTIMORE



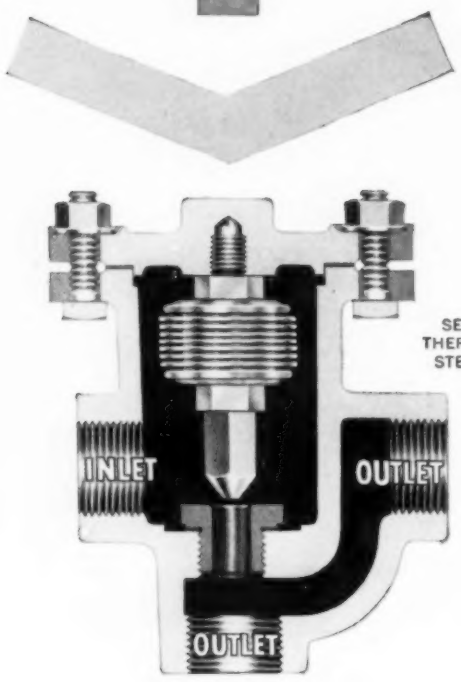
DYNAMIC DRYERS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

THE C. M. KEMP MFG. CO.
405 East Oliver Street, Baltimore 2, Maryland

 (To obtain more data on advertised products see page 222)

Clark FITS TO A "T"



★ LOW INITIAL COST
★ EASY TO INSTALL
★ LOW MAINTENANCE
★ MINIMUM INVENTORY

Ask Your Distributor For These CLARK Fluid Controls

Inverted Bucket Traps	Venting Traps	Pressure Regulators
Open Bucket Traps	Thermostatic Traps	Y-Type Strainers
Float Traps	Vacuum Traps	Pressure Reducing Valves

STANDARDIZE ON THE COMPLETE CLARK LINE

ASK YOUR DISTRIBUTOR OR WRITE DIRECT FOR FREE BROCHURES ON CLARK FLUID CONTROLS

THE Clark MANUFACTURING COMPANY
1832 East 38th St. • Cleveland 14, Ohio

of polyvinyl pipe—regular and high impact. Tables present the mechanical, thermal, electrical and other properties of this corrosion-resistant or impact-resistant plastic pipe. Three graphs give head losses for different flow rates of water through this pipe. Recommended applications and installation hints conclude the catalog. Alpha Plastics Inc., 78 Okner Parkway, Livingston, N.J.

Circle No. **29** *on Reply Card*

Liquid sealant

. . . for locking threaded fasteners: *Technical Report #5* contains a complete discussion of how this new product functions, and its many potential uses. Loctite Sealant is a liquid which can be used in place of lock washers. By proper selection of grade, it can meet many specific locking torque requirements in assembling machines or plant maintenance. American Sealants Co., 103 Woodbine St., Hartford 6, Conn.

Circle No. **30** *on Reply Card*

Steam traps

. . . strainers, separators, and other specialties: *Catalog No. 69* is a 60-page reference for those specifying or designing steam systems. Besides listing specifications and design information for each piece of equipment, the catalog includes a number of useful tables. One is a fold-out table presenting steam trap pressures, capacities and orifice sizes for almost all conditions. Strong Steam Specialties Div., Strong, Carlisle & Hammond, 1392 West 3rd St., Cleveland 13, Ohio.

Circle No. **31** *on Reply Card*

Water jet

. . . exhausters and compressors: *Bulletin 4P* is a catalog and technical bulletin describing company's complete line of this equipment. Vacuum pumps, exhausters for pump priming and evacuating vessels, and for mixing gases and liquids are operated by jets of water. Capacity curves and ratios, and water consumption tables are included in this bulletin. Several tables on evacuating times for specific problems are also included. Schutte and Koerting Co., Cornwell Heights, Bucks County, Pa.

Circle No. **32** *on Reply Card*

Ammonia

. . . one of the most important basic industrial chemicals: a 68-page data book titled *Ammonia* fully describes anhydrous ammonia and ammonia

ACETYLENE

...bright future for an old flame!

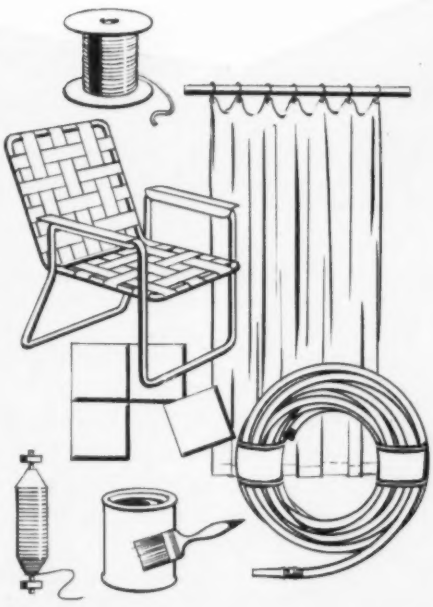
For years the use of acetylene commercially was limited primarily to the welding torch. Today, it is one of the brightest stars on the petrochemical horizon, with some 80% of total output serving as basic raw material for many of the "miracle" synthetic fibres and hundreds of other important plastic products, including *acrylic fibres, resins, solvents,* and *synthetic rubber.*

Key factor in the phenomenal growth of acetylene has been the recent development of processes for its production from natural gas. Among these new production techniques, the BASF process has had the greatest success, because of its commercially proven economy, safety and reliability.

With exclusive rights in all North American countries* for the BASF process, Chemico has designed and constructed facilities for the production of more than 150,000,000 pounds per year capacity of acetylene. This total includes the world's largest plant for producing acetylene from natural gas. This experience enables CHEMICO's highly skilled staff to handle acetylene projects with maximum efficiency and economy.

*On occasion those rights have been extended to other areas, through special arrangement with BASF.

If you are interested in the profit making opportunities offered by acetylene, we suggest you send for CHEMICO's new acetylene brochure (Bulletin No. 257), which will give you more detailed information on the BASF process and CHEMICO's experience in this field.



CHEMICAL CONSTRUCTION CORPORATION

CHEMICO

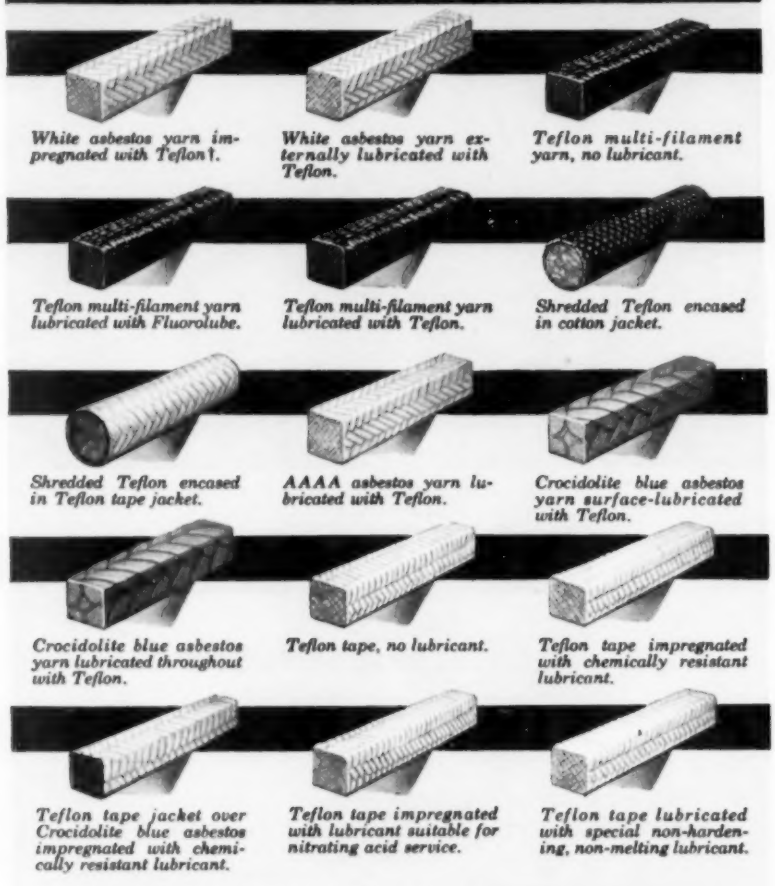
A SUBSIDIARY OF ELECTRIC BOND AND SHARE COMPANY

525 West 43rd Street, New York 36, N. Y. • Cable Address: CHEMICONST, New York

Affiliated Company: CHEMICAL CONSTRUCTION (GREAT BRITAIN) LTD., LONDON, ENGLAND

REPRESENTATIVES in JOHANNESBURG • PARIS • TOKYO

15 SPECIFIC PACKINGS FOR ALL CORROSIVE SERVICES


White asbestos yarn impregnated with Teflon†.
White asbestos yarn externally lubricated with Teflon.
Teflon multi-filament yarn, no lubricant.
Teflon multi-filament yarn lubricated with Fluorolube.
Teflon multi-filament yarn lubricated with Teflon.
Shredded Teflon encased in cotton jacket.
Shredded Teflon encased in Teflon tape jacket.
AAAA asbestos yarn lubricated with Teflon.
Crocidolite blue asbestos yarn surface-lubricated with Teflon.
Crocidolite blue asbestos yarn lubricated throughout with Teflon.
Teflon tape, no lubricant.
Teflon tape impregnated with chemically resistant lubricant.
Teflon tape jacket over Crocidolite blue asbestos impregnated with chemically resistant lubricant.
Teflon tape impregnated with lubricant suitable for nitrating acid service.
Teflon tape lubricated with special non-hardening, non-melting lubricant.

John Crane CHEMLON *BRAIDED PACKINGS

Specific service conditions are always best handled with a packing designed for the purpose. This is especially true when it comes to the hard-to-handle liquids in the chemical, petrochemical and refinery industries.

For this reason John Crane has developed 15 individual field-proved types of Chemlon Braided Packings. Within this line there is a type and style that will meet any combination of service conditions and requirements.

1. All known industrial acids, alkalis or solvents.
2. Temperatures from −120°F to +600°F.
3. High or low shaft speeds, also valve stems.
4. Longer packing life due to lower coefficient of friction and non-raveling construction.

Send in your service condition and we will recommend a Chemlon Braided Packing best suited to your application. Request Bulletin P-325.

Crane Packing Co., 6432 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

†*T. M. for DuPont Teflon* **T. M. for the Best in DuPont Teflon*

CRANE PACKING COMPANY

liquor, their chemical and physical properties, specifications, handling and storage features, and procedures for analysis. Data on viscosities, density, vapor pressures, boiling and freezing points and other properties are presented graphically in this technical booklet. Copies are available by sending requests on company stationery to Nitrogen Division, Allied Chemical & Dye Corp., Dept. ALA, 40 Rector St., N.Y. 6, N.Y.

Do not use Reply Card

Technical report

. . . on a new type of detergent-inhibitor: *Technical Report ELD-7197* is a 14-page report on over 2-million miles of tests in taxis, buses and trucks of PARANOX 302, a detergent-inhibitor. Both gasoline and diesel engines were used, and driving conditions were severe for both city and cross-country tests. Results of all tests are tabulated for quick reading. Enjay Company, Inc., 15 West 51st St., N. Y. 19, N. Y.

Circle No. **33** *on Reply Card*

Plastic pipe

. . . fittings and valves: *Bulletin TTP-119R-557* is a 24-page booklet about polyvinyl chloride pipe and fittings. Made of unplasticized PVC, these injection molded pieces of equipment resist corrosion, both chemical and atmospheric. Other advantages include light weight, smooth surfaces for low losses, easy assembly and non-sparking properties. Tube Turn Plastics, Inc., 2929 Magazine St., Louisville 11, Ky.

Circle No. **34** *on Reply Card*

Basic properties

. . . of polymerized trifluorochloroethylene, commonly called KEL-F: *Bulletin H-JGIF(67.5)JR* is a ten-page technical booklet listing the properties of these halofluorocarbon polymers. These plastics, available in several grades, are extremely stable, resistant to temperatures, chemically inert and are true thermoplastics. They also have high impact strength at both low and high temperatures. Minnesota Mining and Manufacturing Co., 900 Bush St., St. Paul 6, Minn.

Circle No. **35** *on Reply Card*

Boiler makeup water

. . . and two methods of treating: *Reprint 113* compares the history of two boilers at Richfield Oil Co.'s Watson refinery, one for 600-psig steam and one for 700-psig steam. The 600-psig

Corrosioneering News

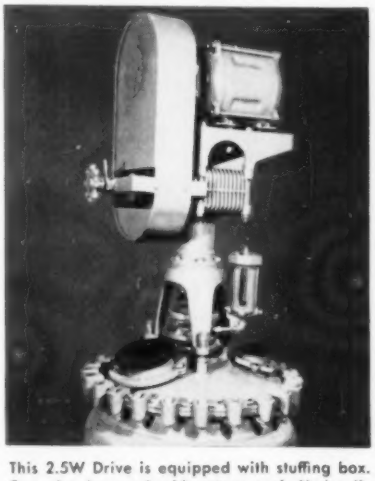
Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., Rochester, N.Y., U.S.A.

New, more compact drive . . . power is higher, agitation range wider

When you can increase the load carrying capacity of a drive without increasing its size, you get at least three extra advantages. You get a wider range of agitation speeds, a compact unit that leaves surrounding area more accessible, and you eliminate cumbersome supports.

All this we have done with our new Type "W" Drives.



This 2.5W Drive is equipped with stuffing box. Can also be used with rotary seal. Hydraulic drives of the new design are available for 100% explosion-proof construction and wide, variable-speed range.

Carry greater loads

These new drives handle heavier loads than any other type of comparable worm gearing. They have what is called a "throated" design—both gear and worm teeth have convex arc shapes—which allows more teeth to mesh simultaneously.

More compact

Notice that the motor is mounted out of the way *above* the drive. This eliminates angular bracing from the top head, permitting a greater number of top head openings. These openings are more accessible and give great flexibility to top head layout . . . particularly valuable features on smaller reactors. (Side mounted motors are available where headroom is limited.)

Hydraulic, explosion-proof drives available

When you want 100% explosion-proof construction and wide, variable-speed range, you can specify hydraulic drives. These can be supplied at the factory or substituted for existing drives in your plant, by converting with hydraulic motors.

The new drives can also be furnished with double reduction gearing and flange-mounted motor. This provides a totally enclosed gear drive with agitator speeds from 525 to 7.3 RPM in 27 increments.

Complete flexibility

You can use the new "W" Drives with stuffing box or mechanical seal on both glassed and stainless steel reactors.

Standard 2.5W, 3W, 4W, and 5W Drives are equipped with constant speed sheaves with static-free belts that can be combined to give any required speed for the agitation you desire.

Complete data on design and performance are in Bulletin 951. Check the coupon for a copy.

New service: customer advisory board reviews Pfaudler designs

The best way to give a customer what he wants is to ask him. Pfaudler did just that by inviting a representative group of management engineers from leading chemical processing plants to appraise design aspects of their standard equipment.

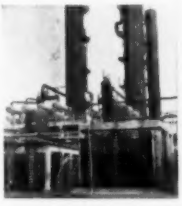
Particularly in the areas of plant hookup, operation, and maintenance, the experience these men have derived from using our equipment complements nicely our design, manufacturing, and field service experience.

The first of the annual meetings of the board was held in May of this year and the commentary more than met our expectations. You will see tangible evidence of the Advisory Board's suggestions in our exhibit at the 26th Exposition of Chemical Industries (December 2-6, New York City).

The Advisory Board is an extension of our continuing efforts to encourage intercommunication between our own personnel and customers. Pfaudler Corrosion Seminars and Maintenance Seminars are still other facets of this program.

We are, of course, always happy to receive your individual suggestions as to how we can serve you better.

Another way of using glassed pipe—jacketed and unjacketed—is in the form of heaters and coolers. Over 10,000 feet were used in making up these polymer heaters and coolers.



Glassed pipe, fittings, valves, vital links in preventing corrosion

Getting materials to and from process equipment presents numerous areas of possible contamination and corrosion. This is why Pfaudler glassed pipe, fittings, and valves make worth-while additions to your corrosion-free reactors, heat exchangers, columns, etc.

The glass in Pfaudler pipe, fittings, valves and accessory equipment is identical to that used on Pfaudler reactors and tanks—resistant to wide range of acid and alkali corrosion and economically justified.

The smooth surface of glass also minimizes friction, speeding up product movement. Cleaning is simplified.

Standard flanged glassed pipe and fittings are available in diameters from 1½" to 12" I.D. for temperatures up to 400° F. and 150 psi. Outlet, safety, diffuser and line valves will also handle a comparable range of temperatures and pressures.

THE PFAUDLER CO.
Dept. PP-97, Rochester 3, N. Y.

Send me bulletins checked: ☐ Bulletin 951, Type "W" Drives ☐ Bulletin 886, Glass Lined Pipe, Fittings and Valves ☐ Bulletin 947, Pfaudler Buyer's Guide.

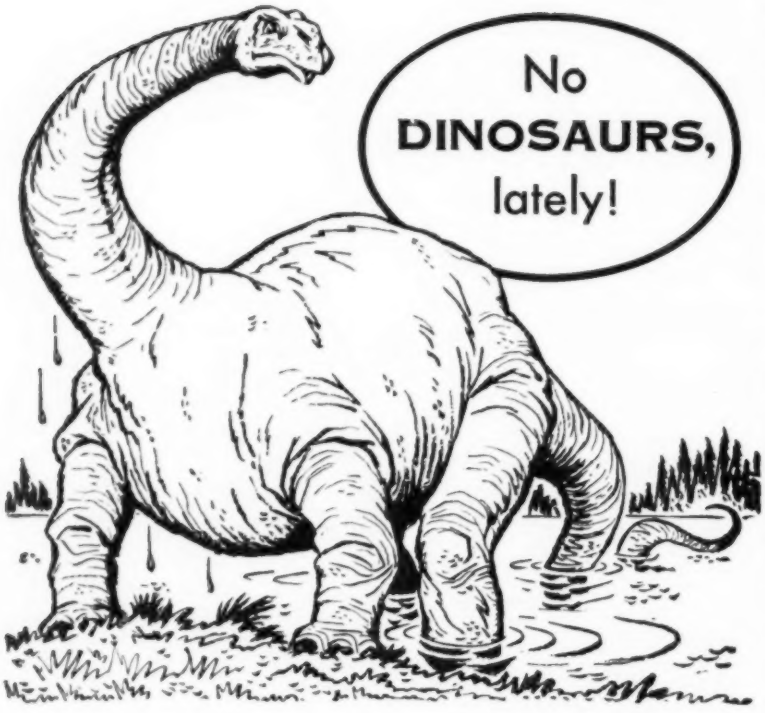
Name ..... Title .....

Company .....

Address .....

City ..... Zone ..... State .....

 (To obtain more data on advertised products see page 222)



The extensive magnesium silicate deposits laid down about the time dinosaurs roamed Florida's marshy peninsula became the source of today's most wisely used adsorbent.

Because it contains numerous small fibrous tentacles, Florida Fullers Earth, in its commercial form known as Florex, is particularly valuable in the adsorptive refining, decolorization, clarification and neutralization of mineral, vegetable, and animal oils, fats and waxes. Florex is unequalled in high quality or low cost for processes involving the use of highly active clay for sweetening light distillates, dehydration, desulfurization, and polymerization.

Standard meshes from 2/4 to 200/up and our experienced adsorption specialists are available to help you solve complex laboratory or production problems.

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Order Reprint R31 . . . 24 pages plus Slide Chart . . . $1.25. Use the Reader Service Card, pp. 223-224, this issue, or send order to PETROLEUM PROCESSING —330 West 42 Street—New York 36, N. Y.

boiler plant used 56% makeup and treated with a conventional hot process lime gypsum single stage plant. The 700-psig boiler plant used 60% makeup, had an economizer, and has treated makeup in a two-stage lime gypsum hot process plant followed by hot zeolite. This report compares the operating results of both systems. Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia 32, Pa.

Circle No. **36** *on Reply Card*

Power reactors

. . . for commercial production of electricity from nuclear energy: *Bulletin GER-1384* is a 27-page review of all types of nuclear reactors which are designed or constructed for this use. A comparison with conventional methods for producing electricity is given, followed by descriptions in word and picture of water, gas, sodium and liquid-fuel cooled nuclear reactors. General Electric Apparatus Sales Div., Schenectady 5, N. Y.

Circle No. **37** *on Reply Card*

Dry feeders

. . . ranging from 1 to 5,000 lb/hr: *Bulletin 20-P2* describes the Omega Universal Feeder, which will feed any dry material. Arching or hanging of material in the hopper is prevented, and the feeding rate is adjustable over a 40 to 1 range. Omega Machine Co., 345 Harris Ave., Providence 1, R.I.

Circle No. **38** *on Reply Card*

Asbestos textiles

. . . for any application or temperature range: *Publication 76-327* is a non-technical but informative bulletin on the uses of asbestos products. Covered in it are cloth, tape, tubing, lap, roving, cord, wick and rope. Over 76 different selections within these groups are possible. A complete table gives the specifications for the most popular cloths made of asbestos, specifying the yarn numbering system used with this product. Fibrous Products Division, Union Asbestos and Rubber Co., 1111 West Perry St., Bloomington, Ill.

Circle No. **39** *on Reply Card*

Wire cloth

. . . for many industrial uses: *Cambridge Woven Wire Cloth, Screens and Products* is a 94-page catalog of the many available kinds of wire cloth and product. Definitions used in this trade, suggestions on ordering, many tables on weight and wire size and openings for all meshes, and a section on what materials to use in this type of cloth

If you could lift the covers . . . you'd find BALDWIN-HILL MONO-BLOCK® and SUPER POWERHOUSE® CEMENT

insulating every vessel heated to 600° F. and over . . . covering all insulated surfaces more than 24" in diameter at

Tidewater Oil Company's New Delaware Refinery

A trainload of 50 cars—over 1,000,000 bd. ft.—of B-H Mono-Block helps prevent costly heat losses and permits better control of operating temperatures. By standardizing on Mono-Block, C. F. Braun Co., Engineers and Constructors, saved stocking separate blocks for both low and high temperatures since Mono-Block is efficient over all temperatures from 75° to 1700° F. B-H Super Powerhouse Cement was used to point all joints and, where required, was applied in a single coat as an insulating-finishing cement.

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For a detailed report on the insulation of this economical installation, just staple the keyed corner of this ad to your letterhead and mail.

J-375

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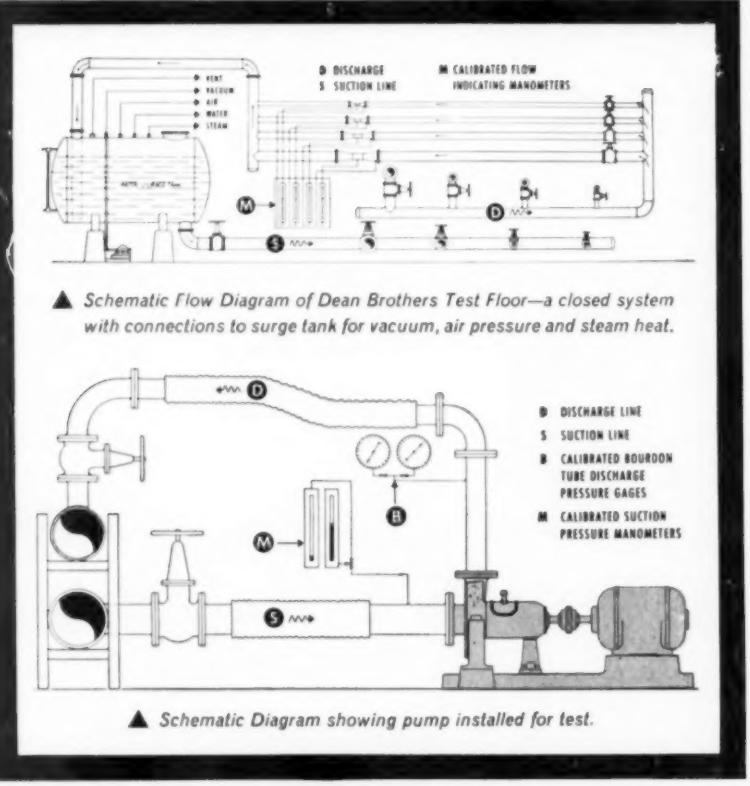
Would you like to have your Process Pumps pre-tested under service conditions?

★ Dean Brothers modern test circuit is a closed, recirculation system as are many process systems. This arrangement permits simulation of process conditions for proving pump performance. Modern instruments produce reliable data on head, capacity, NPSH and efficiency.

Dean Brothers standard centrifugal process pumps are tested on the same system used to provide reliable research information.

The Best is our Standard


D DISCHARGE
S SUCTION LINE
M CALIBRATED FLOW INDICATING MANOMETERS
B CALIBRATED BOURDON TUBE DISCHARGE PRESSURE GAGES
M CALIBRATED SUCTION PRESSURE MANOMETERS

▲ *Schematic Flow Diagram of Dean Brothers Test Floor—a closed system with connections to surge tank for vacuum, air pressure and steam heat.*

▲ *Schematic Diagram showing pump installed for test.*

WRITE FOR SPECIFIC APPLICATION OF OUR TEST EQUIPMENT TO YOUR REQUIREMENTS

DEAN BROTHERS PUMPS INC.
EST. 1869
323 West 10th St., Indianapolis 7, Ind.

are just some of the many bits of useful information presented. Copies may be obtained by writing directly to The Cambridge Wire Cloth Co., Cambridge, Md.

Do not use Reply Card

Positive-flow control

. . . with diaphragm valves, and metering and proportioning pumps: *Catalog No. 800* describes in detail the manufacturer's 4 basic models of proportioning pumps, in the range of 0-730 gph. For each model are shown the materials of construction, capacities and pressures. In the section on diaphragm valves, is a short table on selecting plastics for valve service. Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill.

Circle No. **40** *on Reply Card*

Did you miss these?

The following items were reviewed in the first six issues of 1957. All of them have aroused considerable interest among readers and are repeated here for those who may have missed them when they appeared before. For details or literature, please use the regular Reply Card in this issue.

Electrical probe

. . . detects corrosion in microinches. The Corrosometer measures the progress of corrosion by measuring the loss of a metal probe directly in microinches of metal. The probe can either be immersed in a corrosive solution for instantaneous reading, or mounted permanently in the suspected environment for continuous readings.

Measuring corrosion this way has several advantages. Rapid and direct readings can be made within 30 sec; no shutdown is needed to retrieve metal specimens; measurements can be made in inaccessible spots by using several hundred feet of cable from the probe to the meter; and accumulation of corrosion products do not effect measurement. Crest Instrument Co., 11808 S. Bloomfield, Santa Fe Springs, Calif.

Circle No. **41** *on Reply Card*

New dessicant

. . . has 19 times the water-adsorption capacity of the best silica-type adsorbents, and performs well at temperatures as high as 112°F.

Developed as a new class of dessicants, "Molecular Sieves" have ex-

announcing new # UOP 5-S* INHIBITOR

5 . . . ways better!

1 MOST POTENT of all gasoline antioxidants. Absolute protection from gum formation and TEL decomposition in stored gasolines.

2 MOST VERSATILE inhibitor-sweetener. Handles even gasolines formerly considered "impossible."

3 MOST RAPID sweetening action. *One-fourth to three-fourths faster* oxidation of malodorous mercaptans means a more flexible operation, less storage equipment needed.

4 MOST PROTECTION against engine deposits because phenylene diamine type eliminates their primary cause, gum formation.

5 MOST ECONOMICAL. *Five* molecules of UOP #5-S protect and sweeten a *million* molecules of gasoline . . . a cost of less than ½¢ per bbl.

Universal Oil Products Company has pioneered in the development of products and methods for better, more economical gasoline finishing. If you have a stability or quality problem, drop us a line and we'll be glad to help you to a solution.

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Products Department
UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U. S. A.

 (To obtain more data on advertised products see page 222)

This "heart-failure" can lengthen someone's life!

Pictured above is what happens when a pressure vessel protected by a BS&B Safety Head develops pressures above safe limits. "Heart" of the Safety Head is the rupture disc, which bursts to relieve the overpressure instantly and completely—guarding against injuries to personnel and damage to plant equipment.

BS&B Safety Heads

protect pressure systems in every type industry

Thousands of BS&B Safety Heads are today protecting millions of dollars worth of property and equipment and countless human lives. There's a BS&B Safety Head suitable for many types of pressure systems containing air, gas, steam or liquid.

BS&B Rupture Disc—"Heart" of the Safety Head

BS&B rupture discs are designed to relieve pressures at any specified point from 3 to 100,000 pounds per square inch. They are available in standard sizes ranging from ¼ inch to 36 inches in diameter, and in special sizes and types for virtually any application.

If you use any type of pressured system, let us tell you more about BS&B Safety Heads and rupture discs. Call or write your nearest BS&B office or representative—or write to...

BLACK, SIVALLS & BRYSON, INC.

Safety Head Division, Dept. 2-D9
7500 East 12th St.
Kansas City 26, Mo.

tremely small pores in their crystalline structures that exclude both refrigerant and oil molecules. This permits the entire surface of these crystalline alumino-silicates to adsorb selectively only water molecules. The material will release this water of hydration when heated, with little or no change in crystal structure.

Molecular Sieves have an adsorption capacity of 19 wt-% when used with a concentration of 10 ppm of residual water in Refrigerant-12, at a temperature of 140°F. It can be obtained in the form of hard spherical pellets for use in refrigeration systems, existing adorsption units, or for effective drying in units located in small hot motor compartments. Linde Air Products Co., 30 East 42nd St., N.Y. 17, N.Y.

Circle No. **42** *on Reply Card*

Digital computing

. . . and how to understand its language: a booklet entitled *Symbolic Logic, Binary Calculation and 3C-PACs* is a primer on digital computation that should help clarify the important rudiments of this new tool. The booklet describes the simple rules of symbolic logic, showing how most of the calculations are based upon a system of binary, rather than decimal, numbers. Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.

Circle No. **43** *on Reply Card*

Sonic gas analyzer

. . . accurately monitors gas mixtures by using the differences in sonic velocities of gases. Measurable sensitivities of 0.005% oxygen in air and 0.0061% of hydrogen are possible. This high accuracy is not obtained by sacrificing sensitivity, for the unit retains its high sensitivity from 0 to 100 per cent.

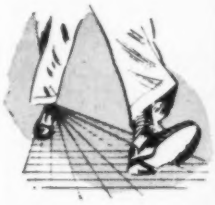
The instrument contains a long tube in which the velocity of sound is measured. Gas is fed into the center and flows out both ends of the tubes, thus cancelling the velocity of gas flow. Sound waves generated at one end of the sonic tube are received by a crystal transducer at the other end. High sensitivity is obtained by using an oscillation frequency of about 150 kc/sec. National Instruments Laboratories, Inc., 6108 Rhode Island Ave., Riverdale, Md.

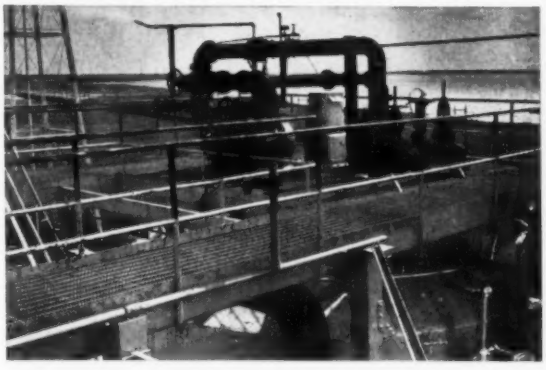
Circle No. **44** *on Reply Card*

Technical manual

. . . on a versatile intermediate: *Ethylene Oxide* is a 43-page technical bulletin presenting available information

WHERE SURE FOOTEDNESS COUNTS





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PALMER

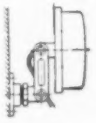
MERCURY ACTUATED
Dial Thermometers now in three types to suit any requirements

PATENTED

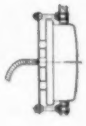
Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 **Rigid Stem Dial Thermometer** tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)

2 **Wall Mounted Dial Thermometer** with flexible connecting armor. Case adjustable to easy reading position.



3 **Flush Mounted Dial Thermometer** for panel mounting with flexible connecting armor.



All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensator. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

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IDEAL Ball Bearing Tube Expanders are made of special analysis alloy tool steels, carefully heat-treated to withstand the severest operating strains. They are adaptable for use with any torque controlled tube rolling units—air, electric or mechanical. *Confidence* is your assurance that your job will be done *RIGHT* . . . when you use WIEDEKE Specialized Tube Expanders, Tube Cutters and Operating Accessories. There is a Wiedeke Distributor in every principal city. For further information write for *new* General Catalog 81.

The Gustav WIEDEKE Company
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on analytical procedures, physical and chemical properties, as well as industrial uses of this material. Data is also included on handling techniques, toxicity, and specifications on the various grades offered by Jefferson Chemical. A documented bibliography lists almost 500 literature references on this petroleum-derived chemical. Jefferson Chemical Co., Inc., P.O. Box 303, Houston 1, Texas.

Circle No. **45** *on Reply Card*

Pocket adding machine

. . . figures with fractions of an inch. It not only computes in feet-and-inches without conversion but also handles fractions of inches with direct conversions.

The Fractometer can be used by engineers, draftsmen, pipe fitters and others who deal with lengths normally expressed in fractions of inches, without converting back to decimals. The device will count up to 100,000.

The pocket-size calculating machine is really two-in-one. The front machine is used for addition and the back for subtraction, with both synchronized to show the same result. For outside work a leather case and a pad is available, or for inside work several types of desk stands are available. This machine is made by Rechenmaschinenfabrik C. Kubler in West Germany and is available in this country from Alexander Drafting Equipment Co., 159 N. Daisy Ave., Pasadena, Calif.

Circle No. **46** *on Reply Card*

Flowmeter

. . . for hard-to-handle fluids such as bunker oils, still bottoms and asphalt has a capacity range up to 450 gpm.

This positive displacement meter is available in sizes from 1 to 6 in., and has an operating temperature range up to 660°F. Operating pressure can be as high as 600 psi. Accuracy of the meter is guaranteed to ¼% for the 1-in. meter and ½% for the 2- to 6-in. sizes. The meter body of meehanite iron is enclosed in a steel steam jacket designed for 15-psi service. Brooks Rotameter Co., Lansdale, Pa.

Circle No. **47** *on Reply Card*

Maintenance symposium

. . . is a collection of seven pertinent articles on maintenance: *The Maintenance of Plants and Facilities* includes four articles previously published by Carl F. Braun on the importance of good maintenance equipment and program. The other articles describe layout and tooling of maintenance shops,

we pay $1 a pound for dust!

Put down that vacuum cleaner bag . . . we're *not* starting a new home industry! You see, the dust we need is a very special kind. All particles must be of a known size . . . and each particle is measured in microns (as you know, a micron is 1/25,400 of an inch). You'd have to put forty microns together to see them with the naked eye.

At $100 per cwt., this dust is important to the contribution we make in fostering industrial growth. We use it in testing and developing filters. These filters provide standards of precision and cleanliness that would have been considered fantastic for commercial production just a few years ago. Using this special dust is just one example of the care and thoroughness that enables us to engineer filtration systems that we *know* will surpass customer requirements . . . that we *know* will perform in the field as well as they do in the laboratory.

Expressed in dollars and cents, this attitude at Purolator has come to mean that it costs less to buy a Purolator filter than to pay for the consequences of operating without one. These consequences may very well be an inferior product, a product that wears rapidly, or even a product that fails to perform at all.

Our job is getting tougher all the time. Leaders in every industry are constantly challenging us to unmask the unknown and provide a solution. But, we have applied our research, engineering skill, quality control and manufacturing facilities to the greatest number of difficult problems in more phases of industry. So it is logical that industry asks us for solutions to their most difficult filtration problems.

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

(To obtain more data on advertised products see page 222)

JOHN ZINK BURNERS

. . . scientifically tested and performance rated to do the job RIGHT . . .

This research furnace affords an ideal proving ground for design changes in standard lines of burners, as well as enabling the John Zink Company to find *workable* solutions to new problems. In this way the John Zink Company can offer you special burners for your individual application . . . burners that have been *performance tested* before they reach your job site.

→ *The facilities of the John Zink research furnace are available to industry.*

WE MAKE HEAT . . . AROUND THE WORLD

If you have a specialized industrial burner problem . . . JOHN ZINK has the answer . . .

JOHN ZINK COMPANY

4401 SOUTH PEORIA TULSA 5, OKLAHOMA

how Esso modernized their Baton Rouge refinery, and the suggestions of three Ethyl men for the maintenance of chemical plants. Copies of this symposium are available from C. F. Braun & Co., Alhambra, Calif.

Circle No. **48** *on Reply Card*

Storage tanks

. . . for many uses: *Graver Standard Storage Tanks* is a 20-page booklet showing the wide range of tanks and vessels which can be obtained from this company. Included is a table of dimensions for standard welded tanks of from 20- to 200-ft diameters. Graver Tank & Manufacturing Co., Inc., East Chicago, Ind.

Circle No. **49** *on Reply Card*

Corrosion guide

. . . for aluminum: *Corrosion Keys for Aluminum* is a graphic presentation of the yearly corrosion rate of more than 100 chemicals and other corrosive materials on this metal. How the rate of corrosion varies with temperature and concentration of the corrosive chemical is cleverly illustrated in graphic color. Reynolds Metal Co., 2500 S. Third St., Louisville, Ky.

Circle No. **50** *on Reply Card*

Glass

. . . and how it's made, how it's used and what it is: *This Is Glass*, a 64-page informative booklet about one of man's oldest chemical products. Included are many pictures showing how glass was manufactured in olden days, and the recent progress in manufacturing this modern material. Many types of glass, their uses, and their properties are described. Corning Glass Works, Corning, N.Y.

Circle No. **51** *on Reply Card*

Reference manuals

. . . on galvanic protection. These are reports of a 6-year project investigating the proper use of zinc as a galvanic anode to protect iron and steel from corrosion. *Zinc as a Galvanic Anode Underground* is a 40-page manual on the details of designing galvanic systems to protect underground pipes, tanks and tower footings. *Zinc as a Galvanic Anode Underwater* is a 16-page report on cathodic protection of ships, water storage tanks, piling and traveling water screens. Both manuals are available from American Zinc Institute, Inc., 60 East 42nd St., N.Y. 17, N.Y.

Circle No. **52** *on Reply Card*

LARGER SIZE RANGE

MIDWEST ELBOWS

IMPROVED DELIVERY

HEAVY WALL CARBON STEEL AND ALLOY

12″ Long Radius
2¼″ Wall Thickness
1¼% Chrome

20″ x 10″ Reducing
2″ Wall Thickness
2¼% Cr—1% Mo.

STRAIGHT LONG RADIUS 90° ELLS

Nominal Pipe Size	Maximum Wall Thickness
36	1.250
30	2.000
26	2.000
24	1.500
20	1.375
18	2.250
16	2.125
14	1.750
12	2.000
10	2.000
8	1.750
6	1.000
5	.625
4	.750
3	.625
2½	.375
2	.500

These straight elbows can be furnished with LONG TANGENTS at no extra cost. All thicknesses less than those shown above are, of course, available.

The exclusive Midwest method of making all welding elbows from plate instead of tubing gives us a FLEXIBILITY OF MANUFACTURE that is much greater than by any other process. These heavy wall Midwest straight and reducing elbows are available in any material that can be secured as plate. The maximum wall thicknesses for which we now have equipment are indicated by the tables at left and right. And, because it is easier to get plate than tubing, better delivery is another advantage. Still another is the close tolerances inherent in our process.

Quality control goes beyond all code requirements. The longitudinal weld of every heavy wall elbow is completely X-rayed as standard procedure in our method of manufacture.

You will find it to your advantage to send us your inquiries.

REDUCING LONG RADIUS 90° ELLS

Nominal Pipe Size	Maximum Wall Thickness
30	2.000
26	*
24	2.000
20	2.000
18	2.000
16	1.500
14	1.750
12	2.250
10	2.000
8	1.750
6	1.000
5	.625
4	.750
3	.625
2½	.375
2	.500

Reductions to all nominal pipe sizes down to ½ large diameter. All thicknesses less than those shown above are, of course, available.
*Refer to factory.

MIDWEST PIPING COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo. • Plants: St. Louis, Clifton, N. J. and Los Angeles

Sales Offices

ASHEVILLE (BOX 446, SKYLAND, N.C.)
BOSTON 27—426 FIRST ST.
CHICAGO 3—79 WEST MONROE ST.
CLEVELAND 14—616 ST. CLAIR AVE.
HOUSTON 2—1213 CAPITOL AVE.
LOS ANGELES 33—520 ANDERSON ST.
MIAMI 34—2103 LE JEUNE RD.
NEW YORK 7—50 CHURCH ST.
ONEIDA, N.Y.—282 NORTH MAIN ST.
SAN FRANCISCO 11—420 MARKET ST.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

The Last Word

With this issue and this page, PETROLEUM PROCESSING brings its editorial career to a close, for reasons explained briefly on pg. 7.

Rather than lamenting our demise, we'd like to pay a final tribute to the petroleum processing industry and the people in it.

No industry, no company, no individual is an island unto himself—entirely self sufficient and capable of generating all the new ideas needed for growth and development. An interchange of information is necessary—both within that industry and between it and other industries. And that interchange must be a give and take proposition.

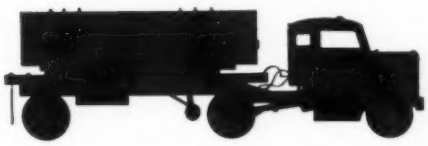
It is to the credit of the petroleum processing industry—and the people who make it up—that it has recognized this need and its responsibilities. In no other industry with which we are familiar is there such a lack of the usual "trade secrets."

Our industry has given PETROLEUM PROCESSING, as well as the other magazines devoted to petroleum, sincere and full-hearted support. In no way can the decision to discontinue PETROLEUM PROCESSING be charged against the industry it has served.

It is the fact that this need for information is so well recognized which makes us sure that PETROLEUM PROCESSING—even though published no more—will be neither gone nor forgotten.

The information we have printed in our articles and reports in the past will not be as timely in the future as when it first appeared in our pages, but it will still be available in the literature for many years to come. And it will continue to help the people who read it to move ahead and do a better job.

For FLUORINE gas or liquid



HYDROFLUORIC ACID aqueous or anhydrous

INORGANIC FLUORINE COMPOUNDS

see GENERAL CHEMICAL

General Chemical's leadership in fluorine chemistry is well established . . . widely recognized. The inorganic fluorine compounds listed here are available now—in commercial or research quantities. Many others are under investigation, or can be produced readily if required. Whenever you need fluorine chemicals of any type—call *General Chemical*, industry's primary source of supply for elemental fluorine, hydrofluoric acid and the fluorine compounds produced from them.

FLUORINE
Elemental Fluorine, Gaseous & Liquid

ACIDS
Fluoboric Acid
Fluosulfonic Acid
Hydrofluoric Acid, Anhydrous
Hydrofluoric Acid, Anhydrous High Purity
Hydrofluoric Acid, Aqueous
Hydrofluoric Acid, Aqueous, Purified & Reagent
Hydrofluoric Acid, Electronic

ACID FLUORIDES
Ammonium Bifluoride
Potassium Bifluoride
Sodium Bifluoride

ALKALI FLUOBORATES
Ammonium Fluoborate
Potassium Fluoborate
Sodium Fluoborate

ALKALI FLUORIDES
Ammoninum Fluoride
Potassium Fluoride, Crystal & Anhydrous
Sodium Fluoride, Technical
Sodium Fluoride, Reagent

BORON FLUORIDE COMPLEXES
Boron Fluoride Ether (Diethyl) Complex
Boron Fluoride Phenol Complex
Boron Fluoride Diacetic Acid Complex
Boron Fluoride Di-n-Butyl Ether Complex
Boron Fluoride Dihydrate
Boron Fluoride Piperidine Complex
Boron Fluoride Ethyl "Cellosolve" Complex
Boron Fluoride Hexamethylene-tetramine Complex
Boron Fluoride Monoethylamine Complex
Boron Fluoride Para-cresol Complex
Boron Fluoride Triethanolamine Complex
Boron Fluoride Urea Complex

DOUBLE FLUORIDES
Chromium Potassium Fluoride
Potassium Ferric Fluoride
Potassium Nickel Fluoride
Potassium Titanium Fluoride
Potassium Zinc Fluoride
Potassium Zirconium Fluoride
Sodium Zirconium Fluoride
Sodium Silico Fluoride
Potassium Aluminum Fluoride

HALOGEN FLUORIDES
Bromine Trifluoride
Bromine Pentafluoride
Chlorine Trifluoride
Iodine Pentafluoride

METAL FLUORIDES
Aluminum Fluoride
Aluminum Fluoride, Crystal
Antimony Trifluoride
Antimony Pentafluoride
Barium Fluoride
Bismuth Trifluoride
Cadmium Fluoride
Calcium Fluoride
Chromium Fluoride
Cupric Fluoride
Lead Tetrafluoride
Magnesium Fluoride (Not Optical Grade)
Mercuric Fluoride
Manganese Trifluoride
Molybdenum Hexafluoride
Nickelous Fluoride
Selenium Hexafluoride
Silicon Tetrafluoride
Silver Difluoride
Stannous Fluoride
Strontium Fluoride
Titanium Tetrafluoride
Tellurium Hexafluoride
Tungsten Hexafluoride
Zirconium Tetrafluoride

NON-METALLIC FLUORIDES
Boron Fluoride, Gas
Sulfur Hexafluoride

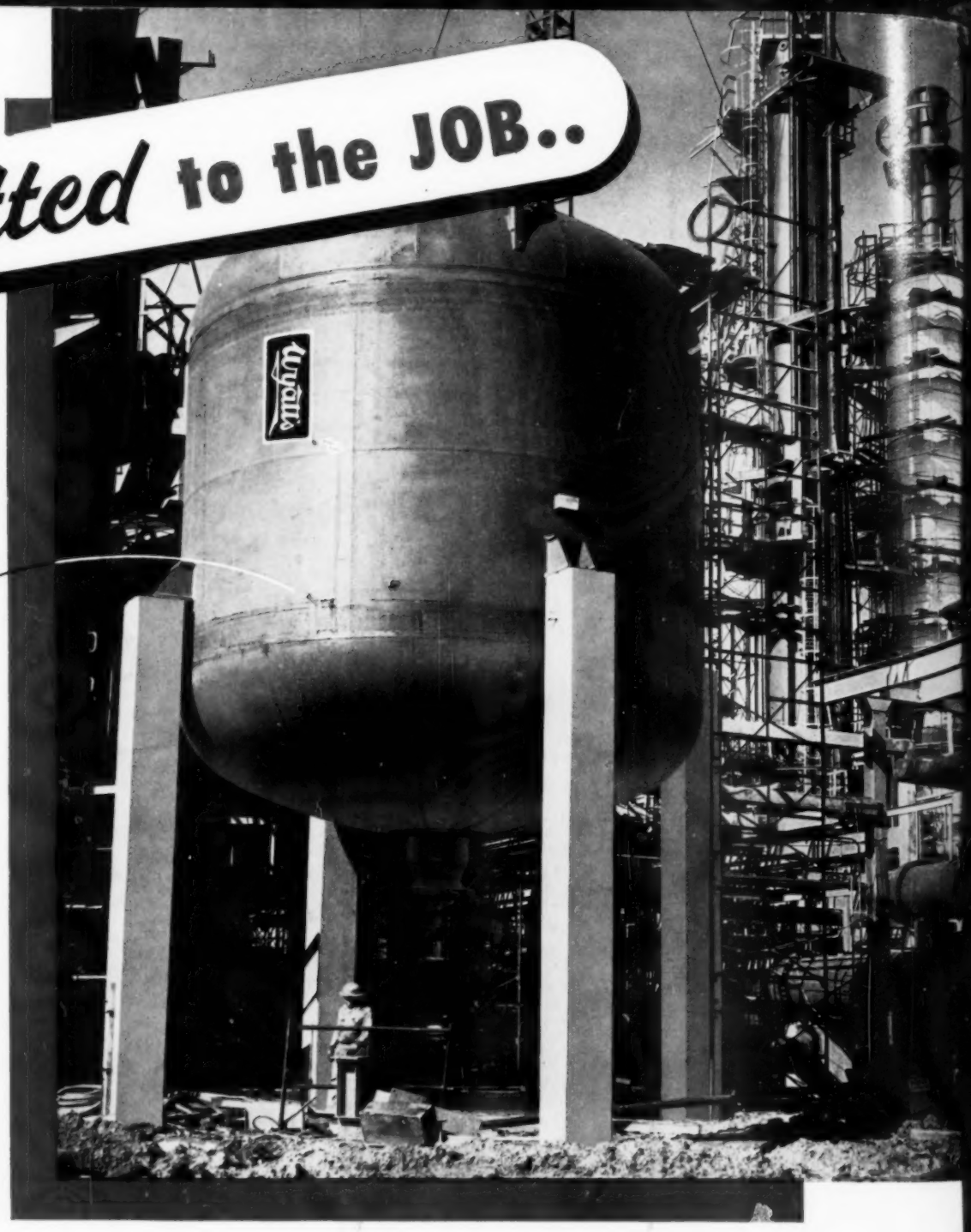
METAL FLUOBORATE SOLUTIONS
Cadmium Fluoborate
Chromium Fluoborate
Cobalt Fluoborate
Copper Fluoborate
Ferrous (Iron) Fluoborate
Indium Fluoborate
Lead Fluoborate
Nickel Fluoborate
Silver Fluoborate
Stannous (Tin) Fluoborate
Zinc Fluoborate

GC Allied Chemical

Basic Chemicals for American Industry

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Fitted to the JOB..



● This Reactor in the Expansion of a Gulf Coast Refining Plant operates at 530 pounds W.P., and temperature of 750°F.

Fabricated from ASTM A-204 Plate 3-11/16 inches thick: All seams 100% radiographed and completely stress relieved.

Shipped in one piece from Wyatt's Houston Plant to final destination.

* Overall Length 27 feet, 2 inches
* Inside Diameter 18 feet, 3 inches
* Weight 215,000 pounds

Wyatt's
HOUSTON-DALLAS-NEW YORK-TULSA

MANUFACTURERS AND ERECTORS SINCE 1918